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**COVER:** A seahorse carved of fossilized walrus ivory (20,000 years old) against a background of Brazilian amethyst. The carving is in the collection of Lee Downey (Artifactual), Aptos, California. (Photo by Earl Lewis)

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# IVORY

## The Forbidden Gem

*This 6-inch ivory carving of an old man and his dangerous-looking pet was done in China. (Jeff Kurtzeman photo)*

### Today's Lapidaries Find Alternatives to Elephant Tusks

*by Bob Jones*

Once upon a time, ivory hunters supplied the gem-carving market with all the ivory it could use. In both Africa and India, the elephant was hunted for his beautifully curving tusks, which are really incisor teeth that continue to grow until the animal's death. Ivory was valuable enough to give rise to fanciful tales of explorers finding elephant graveyards rich in ivory. I even saw a Tarzan movie about such a treasure trove when I was a kid.

Fortunately, we realized the elephant population was being seriously threatened, and in 1990 an international group developed laws that made the importation of ivory illegal. Laws were also passed in countries where the big beasts live to stop indiscriminate hunting. This hasn't totally stopped the now-illicit trade in ivory, but it sure has helped. If you see something done in ivory for sale today, the seller had better have some proof that what is being sold is either very old or some other form of ivory.

The laws did not shut down the use of ivory in gem work completely. Ivory can be obtained from sources other than elephants. There are other animals whose teeth are a form of ivory, the hippo and the walrus, for example. Of course, a hippo tooth may not be more than 6 inches long, and a walrus tusk might reach a couple of feet, a far cry from the huge tusks some African elephants manage to develop. Some exceptional tusks reach 6 feet or more in length.

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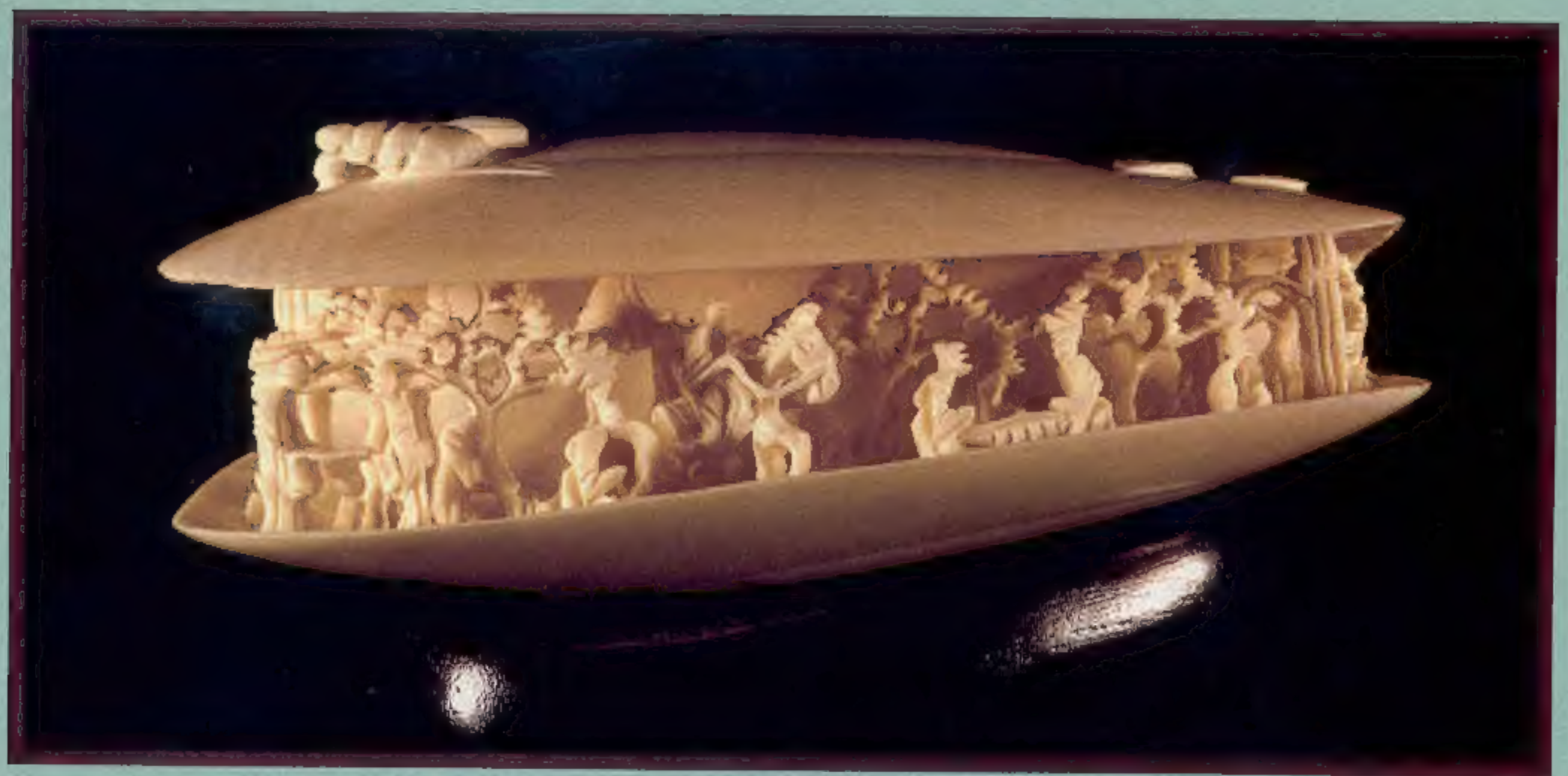

*This 4-inch carving in elephant ivory is typical of what is being done in China today. (Jeff Kurtzeman photo)*

*This painted ivory carving, circa 1896, preserves the original curvature of the elephant tusk. (Bob Jones photo/Courtesy Suzanne O'Brien)*

*This superb jeweled ivory carving was done in India using ivory from that country. (Bob Jones photo)*

*Choice modern jewelry by Jesse Monongye incorporates coral, Tahitian black pearls, turquoise, and mastodon ivory. (Bob Jones photo)*

# IVORY: The Forbidden Gem *from page 12*

Of course, there were a couple of ancestral "elephant" types that grew larger tusks. The Imperial elephant of California, for example, might boast a tusk—keep in mind it's a tooth—as long as 13 feet. Imagine the neck muscles needed to haul such a load around. Actually, ivory isn't extremely heavy, since the tusk is hollow along much of its length. If you've never seen an Imperial elephant, don't despair. They lived eons ago. You can see a beautiful skeleton of one with its long, curving tusks on display at the La Brea Tar Pits Museum in central Los Angeles. It's right on La Brea Boulevard, of course!

Another ancient creature that had big tusks is the woolly mammoth, whose remains are still being found in Siberia and Alaska. Mammoth tusks were several feet long and have been used throughout history as gem material. It is surprising how many of these huge beasts have been unearthed in Siberia. And don't forget the mastodon, another old-timer. These big beasts roamed the land at one time and were even hunted by what we call "cave man."

Still, the ivory of choice has always been that of the elephant, both from India and Africa. Carved bits of ivory have been found in caves around Dordonge in France and in early habitats in Switzerland. Even King Tut had some carved ivory pieces in his tomb.

When found, the tusks of the mastodon are apparently not as good to use for carving as elephant tusks, since they tend to be softer. If you buy something of ivory and the seller assures you the piece is really mammoth ivory and so is perfectly legal to sell, you might run a check on it. There is a way to visually distinguish between elephant ivory and fossil mammoth ivory. You'll notice that ivory tends to have tiny lines, or striations, in it. Using a powerful lens like a jeweler's loupe, examine the ivory for those striations. Note that the striations tend to crisscross. Both elephant and mammoth ivory will show such very fine lines.

To distinguish between elephant and mammoth ivory, check the angles of intersect of the striations. In elephant ivory, the visible lines intersect at angles in excess of 115 degrees. In mammoth ivory, the intersects are 90 degrees or less. It takes a strong glass and good light to see this. It is best to use a microscope, but if you can distinguish those crisscrossing lines and figure the angles, you can tell which is which. Cellulose, an oft-used substitute for ivory, shows no such striations. You can also test ivory by burning it, though I'm not sure anyone would try that unless using a small sliver of some unimportant item. When ivory is burned, it smells of burned protein and turns black.

***Ivory can be carved into exquisitely detailed figures using simple woodworking tools. (Bob Jones photo)***

In part because of the current import laws and because of the very restrictive hunting laws in both India and Africa, the supply of ivory is minimal compared to what the industry was using 700 to 800 years ago. Add to that the continuing effort to limit the hunting of whales, another source of ivory, and you can see why ivory carving has fallen into severe decline.

Two whales have traditionally been used for ivory. One is the narwhal, that creature with an extremely long, spiraling, spearlike thing sticking out of its face. Only the male narwhal can boast such a growth. The thing can reach a length of 9 feet! The other whale is one I had never heard of, a cachalot whale. Because of the restrictions and the natural resistance that has built up among buyers who prefer not to support what might be illegal, ivory carving is almost a lost art.

Thanks to the laws that protect these regal beasts we can still go where they live and enjoy the thrill of seeing such creations. Having been face to face (within 15 feet) with a huge bull elephant on his own feeding grounds in Namibia, I can really appreciate the beauty and power of these huge creatures and applaud the laws that protect elephants. I could no more pick up a gun and shoot an elephant, except for self-preservation, than get in a barrel and ride over Niagara Falls.

Keep in mind that elephants back in ancient times roamed the African plains by the millions. Today, there may be fewer than a half million of the ponderous beasts. One set of reported figures found in the book *Gems, Their Sources, Descriptions and Identification,* by R. Webster, says that during Roman times it is estimated that there were some tens of millions of elephants roaming the grasslands of Africa. So we can appreciate the protection laws and be content with enjoying ivory carvings done decades and even centuries ago before those laws saved the pachyderms from extinction. True, there is poaching and some ivory trickles out of India and Africa, but the huge market in ivory as a gem has pretty much dried up, except for fossil ivory, vegetable ivory, and the teeth of various creatures. That's a good thing.

Through the centuries, ivory has been an eagerly sought gem material, especially in China and the Far East. Wonderful carvings of animals, superb carvings of gods and goddesses, warriors on horseback, and a host of other subjects common to the day were done centuries ago. Most of all, I like those intriguing carved spheres within spheres, which hold a special fascination for people. I'm sure you've seen those marvelous creations of the patient carver: a fist-sized sphere of creamy ivory, carved in open relief. Inside is another sphere, usually an image of the outer sphere, smaller and completely unattached to the outer sphere, so it rotates. And inside that is yet another, even smaller, perfectly carved ivory ball. One example in the Lizzadro Museum of Lapidary Art is a sphere on a pedestal that has 24—count them, 24—spheres, one inside the other. I find that mind-boggling. It is hard to imagine the time it must have taken to carve something like that, even though ivory is relatively easy to carve.

Figures were done the same way during the Ming Dynasty. They are called two- and three-stage carvings, with figures inside figures, and so on. They were perfectly done, front and back.

While Chinese ivory carvings have been done for centuries, it wasn't until

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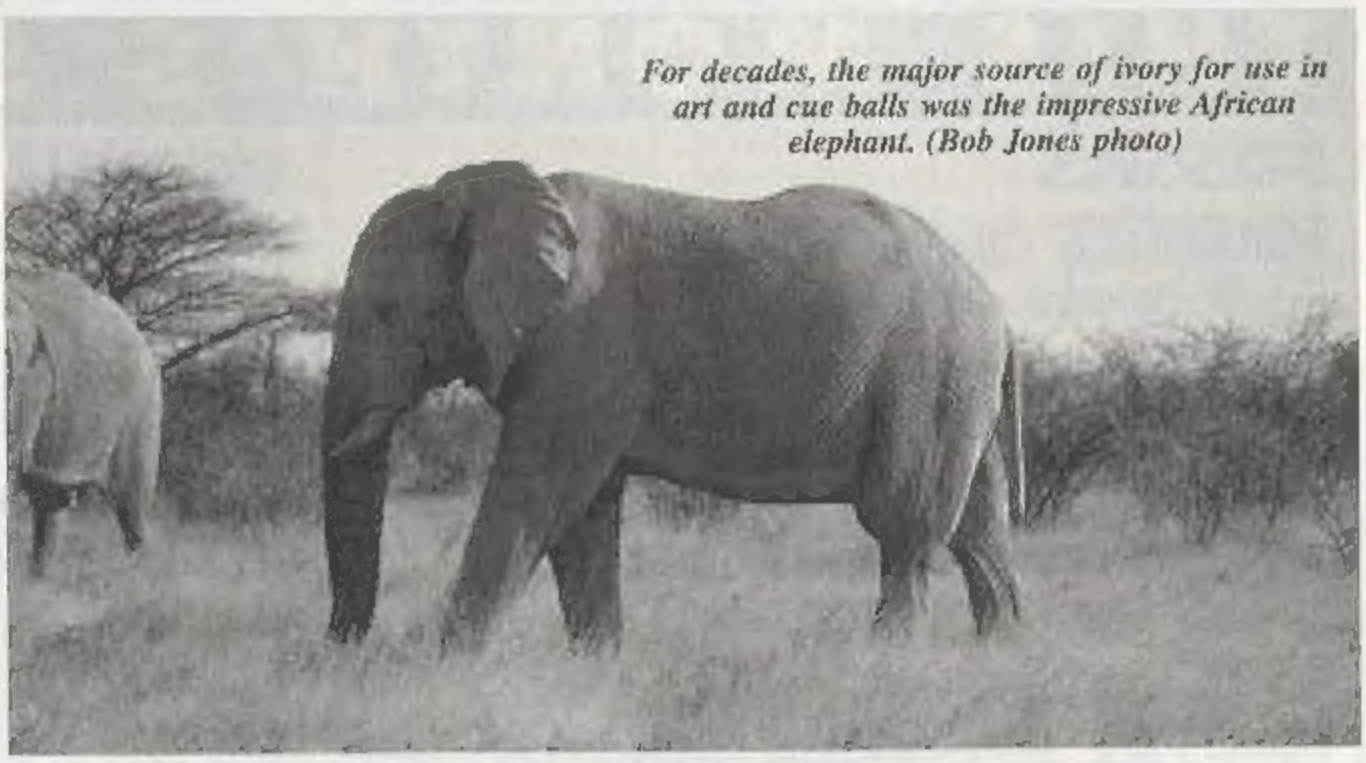
# IVORY: The Forbidden Gem *from page 14*



*For decades, the major source of ivory for use in art and cue balls was the impressive African elephant. (Bob Jones photo)*

the 13th century that ivory became its most popular in Europe. This coincided with the Marco Polo event. According to the Webster book on gems, it was during the Yuan Dynasty that objects carved in ivory began to be produced in quantity. It was during that time period, in the 1200s, that an official department of ivory carvers was set up in the palace of the Mongol ruler, Kublai Khan, grandson of the great Genghis Khan.

Kublai Khan was a strong supporter of the arts; the production of ivory carvings was just one facet of his efforts to promote them. Imagine the amount of ivory being worked at that time, how many tens of thousands of beautifully carved objects still exist in museums and private collections that were carved during that period or after. Imagine the elephants, mostly from India, that died to keep that industry in high production.

What makes ivory so popular among buyers is its creamy yellowish-white color and lovely fine-grained luster. Artists love it because it works easily even with woodworking tools. It does come in varying degrees of hardness, but generally runs between 2 and 3 on the Mohs scale. So none is too hard to work with common tools.

Ivory is really dentine, and not the chewing gum type, either. Elephant tusks, the most popular, and now forbidden, source of ivory, are actually teeth that forgot to stop growing! The curvature is due to the positioning of the tooth in the socket, which affects how it grows out.

The chemistry of ivory is interesting. Since it is really a tooth, it has a composition not unlike your teeth. Of course, the enamel on an elephant tooth is only on the pointy end, or you'd need something harder than woodworking tools to accomplish much. Your teeth are composed of hydroxyl-apatite and another mineral called whitlockite, a quite rare mineral in nature. Elephant ivory is very nearly the same stuff, hydroxyl calcium phosphate with a little collagen and elastin, both organic compounds. This makes ivory slightly elastic and bendable in thin plates.

China is just one country that enjoyed using ivory for carvings. Japan was just as active in the ivory trade. Have you ever noticed that the really good-sized ivory carvings have a slight curve to them? This is done on purpose, as the artist is, by tradition, expected to follow the natural curve of the tusk. In smaller things, like netsukes, this doesn't enter into the work, but when carving figures or things in nature, the curve is to be preserved. The ultimate in elephant ivory carving was to carve the entire tusk from one end to the other. A tusk could be carved in one of two ways, either as a free-standing, vertical series of figures, trees, etc., or as a horizontal scene of villages, landscapes, or what have you.

Netsukes are one of the carved objects you see a lot of these days. People enjoy collecting them because of their variety and relative availability. These are usually little 2-inch-high ivory carvings of figures—warriors, revered ancients, religious types, and the like. According to Webster in *Gems, Their Sources, Descriptions and Identification*, which I highly recommend, the word netsuke means "a root to hang something on." And that is exactly what netsukes were used for in Japan, where they were most popular. They were used as a belt hook upon which a tool or weapon could be hung. Or they were used like buttons to slip through loops sewn into clothing. They were also used for utility things like handles. So, ivory was a major import into Japan. It is also interesting to note that Japan is not exactly in favor of ending the hunt for whales. Good thing elephants don't live in Japan!

I've already mentioned the woolly

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# IVORY: The Forbidden Gem *from page 16*

*This Chinese ivory carving shows a delightful and very detailed scene. (Bob Jones photo/Courtesy Lizzadro Museum of Lapidary Arts)*

mammoth as a source of ivory. Mammoths lived on Earth starting 200,000 years ago during the Pleistocene era. You see them represented in museum paintings and dioramas showing that time period. The Imperial elephant, on the other hand, was more recent. As we said earlier, remains of this huge beast have been found in the La Brea tar pits along with the saber-toothed cat and delicate bird "fossils." The pits date back just a few thousand years. A visit to the La Brea Tar Pits Museum is a real treat, as you not only see the skeletal remains of these creatures, but you can also check out an exposed pit area and see bones still locked in the hardened bitumen. Since the creatures found trapped here were enclosed in the preserving tar, the bones actually did not fossilize in the true sense of the word. Instead they were impregnated with the petroleum substances and preserved in a more natural condition. Bird bones found here, for example, are still hollow!

On the other hand, when a mammoth was buried in the mud of Siberia, the flesh would rot away, leaving only the hard parts to be invaded by mineral solutions and become fossilized. Of course, in the far reaches of Alaska and especially Siberia, these creatures were quick-frozen, and not only was the flesh preserved, but so were the stomach contents, so we know what they ate. And speaking of eating, some scientists, after first testing the meat by feeding it to dogs, actually ate bits of the mammoth flesh. Good for them! I've often wondered if a little mammoth DNA could be retrieved from one of those ancient creatures? That could start a whole new series of movies about the mammoths that invaded New York or some such! Be that as it may, the remains of mammoths occasionally show up and the tusks sometimes become available for carving, depending on who gets to the carcass first.

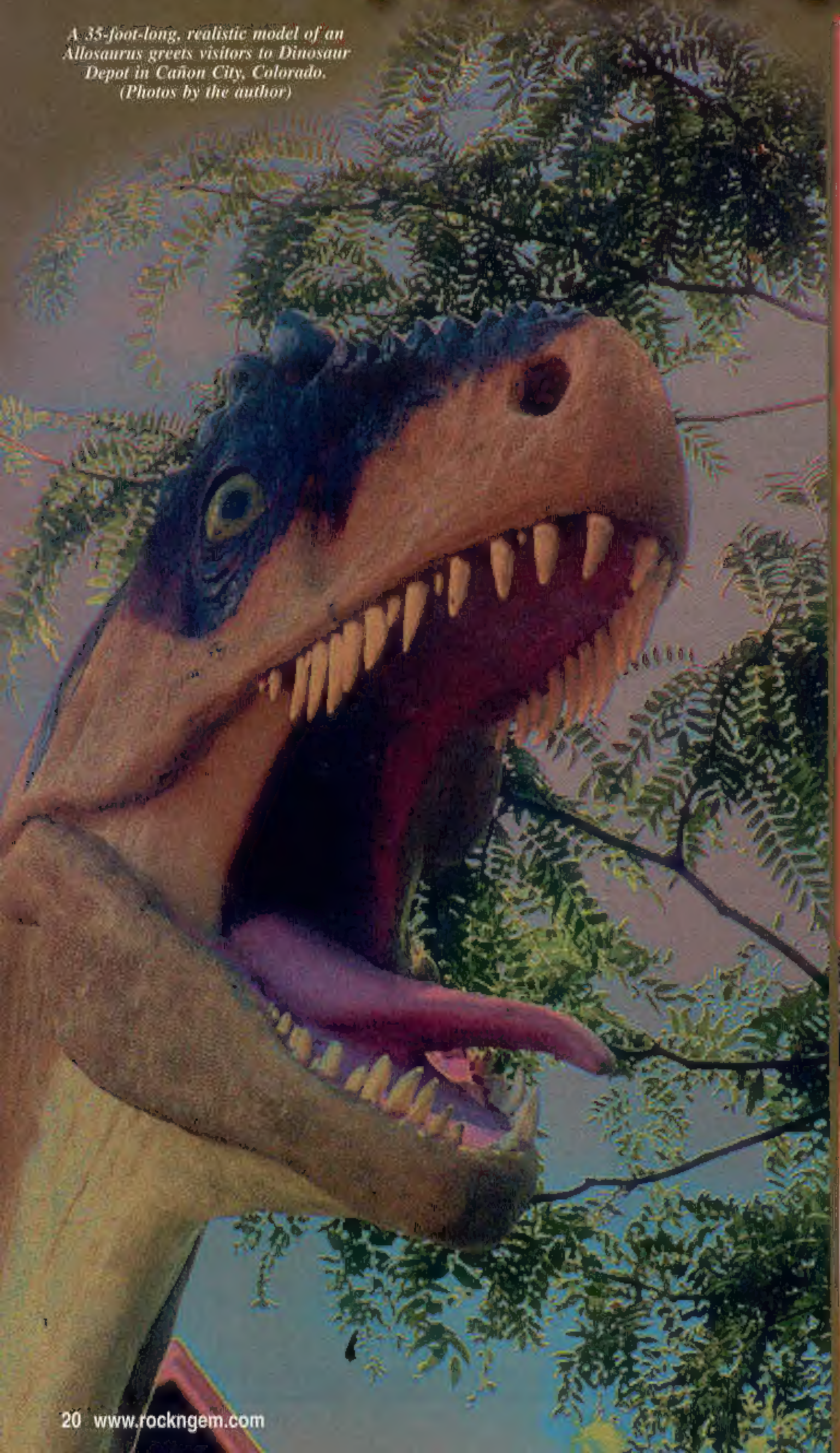
As animal ivory has become less available, another source of ivory has become more popular, the hard, ivorylike nut of the nut palm, which grows in tropical regions. These nuts, often called tagua nuts, are about the size of a golf ball, sometimes a bit bigger. They tend to be slightly flattened and have a brown skin on them. They carve nicely and can be used in place of ivory for small decorative items. They are not ivory of course, as palm trees don't grow teeth! They are, instead, a combination of several organic minerals. Tagua nuts are basically plant cellulose, so they do not show the striations of ivory. In any event, they present the artist with a less expensive white to cream ivory substitute.

You might wonder what artists use for white material when they work. In jewelry there is little problem, because any number of pure-white minerals can be used. Aside from the occasional piece of mammoth tusk or illicit Indian elephant piece that surfaces or the teeth from sea creatures, there isn't much around. Luckily for scrimshanders, there are still plenty of teeth available for their interesting line-drawing artistry, which is much like the carving early sailors did to pass the time.

Still, we do have the wonderful array of ivory carvings to be seen in museums and private collections while being able to enjoy watching the pachyderms of Africa roam free. That's a pretty good trade-off as far as I'm concerned.

FIELD TRIP

# The REAL



*A 35-foot-long, realistic model of an Allosaurus greets visitors to Dinosaur Depot in Cañon City, Colorado. (Photos by the author)*

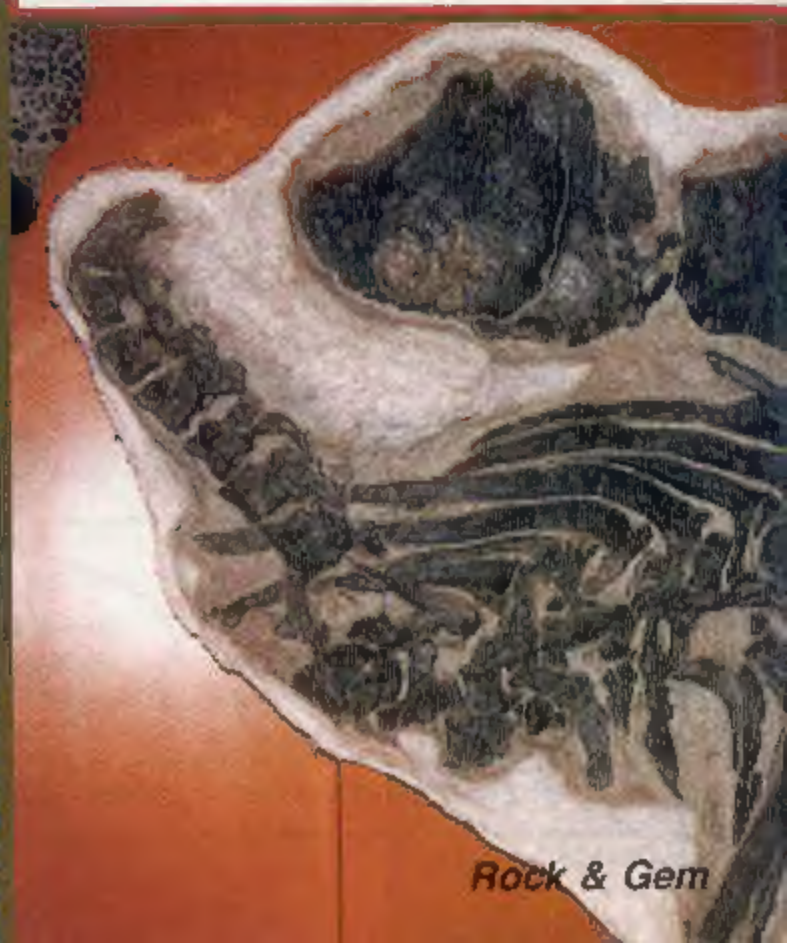
## Cañon City, Colorado, Yields Landmark Fossils

***by Steve Voynick***

To see computer-generated images of dinosaurs in action, you can watch a rerun of the 1993 motion picture "Jurassic Park." Hollywood's version of the Michael Crichton novel by the same name. But to see an authentic "Jurassic Park," complete with fossils and rich paleontological history, you'll have to visit the Dinosaur Depot museum and Garden Park Fossil Area at Cañon City, Colorado.

Numerous exposures of the fossil-rich, late-Jurassic Morrison Formation have made the Cañon City area one of the world's great sources of dinosaur fossils. In the late 1870s, fossilized dinosaur skeletons unearthed here helped trigger the legendary "Bone Wars" among 19th-century paleontologists and opened the door to our modern understanding of dinosaurs.

Even today, after 125 years of paleontological excavation, Garden Park, located eight miles north of Cañon City, continues to yield landmark fossils. In just the past



# Jurassic Park

decade, paleontologists have recovered a complete Stegosaurus skeleton, hundreds of fragments of dinosaur eggshells, and even a rare Jurassic-age petrified tree trunk.

Cañon City, nestled in the foothills of the Colorado Rockies, 20 miles due west of the city of Pueblo and roughly two and a half hours driving time southwest of Denver, was founded in 1860 after the Pikes Peak gold rush opened Colorado Territory to Anglo settlement. But prospectors in the Cañon City area were disappointed in their search for gold, finding only deposits of coal and gypsum. The biggest hopes for early economic development came when natural petroleum seeps were discovered north of Cañon City along a drainage appropriately named Oil Creek. By 1863, the first producing petroleum wells west of the Mississippi were providing modest amounts of petroleum for processing into lubricants and lamp oil.

Nevertheless, Cañon City's fame would come neither from minerals nor petroleum, but from fossils, which prospector Marshall Felch first discovered in 1876 near Oil Creek in a tract of highly eroded badlands called Garden Park. Untrained in paleontology, Felch initially assumed that his massive, 6-foot-long fossils were petrified tree trunks. But a year later, Kansas State Geologist Benjamin Mudge visited Cañon City and correctly identified them as dinosaur bones. Reflecting Mudge's identification, the Cañon City *Avalanche* reported that these bones represented "a portion of the frame of one of those monster animals which in the past must have occupied the Earth."

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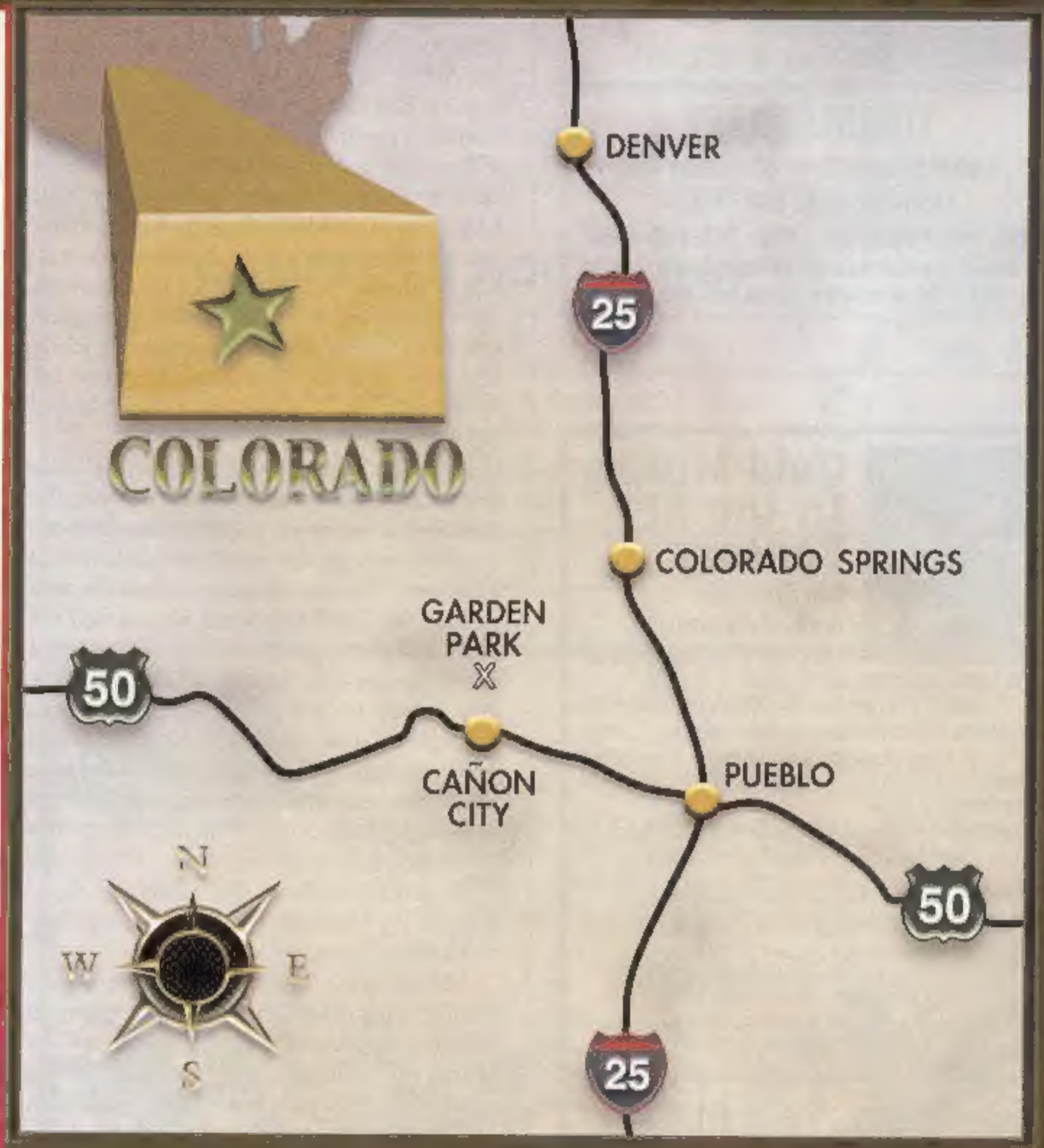
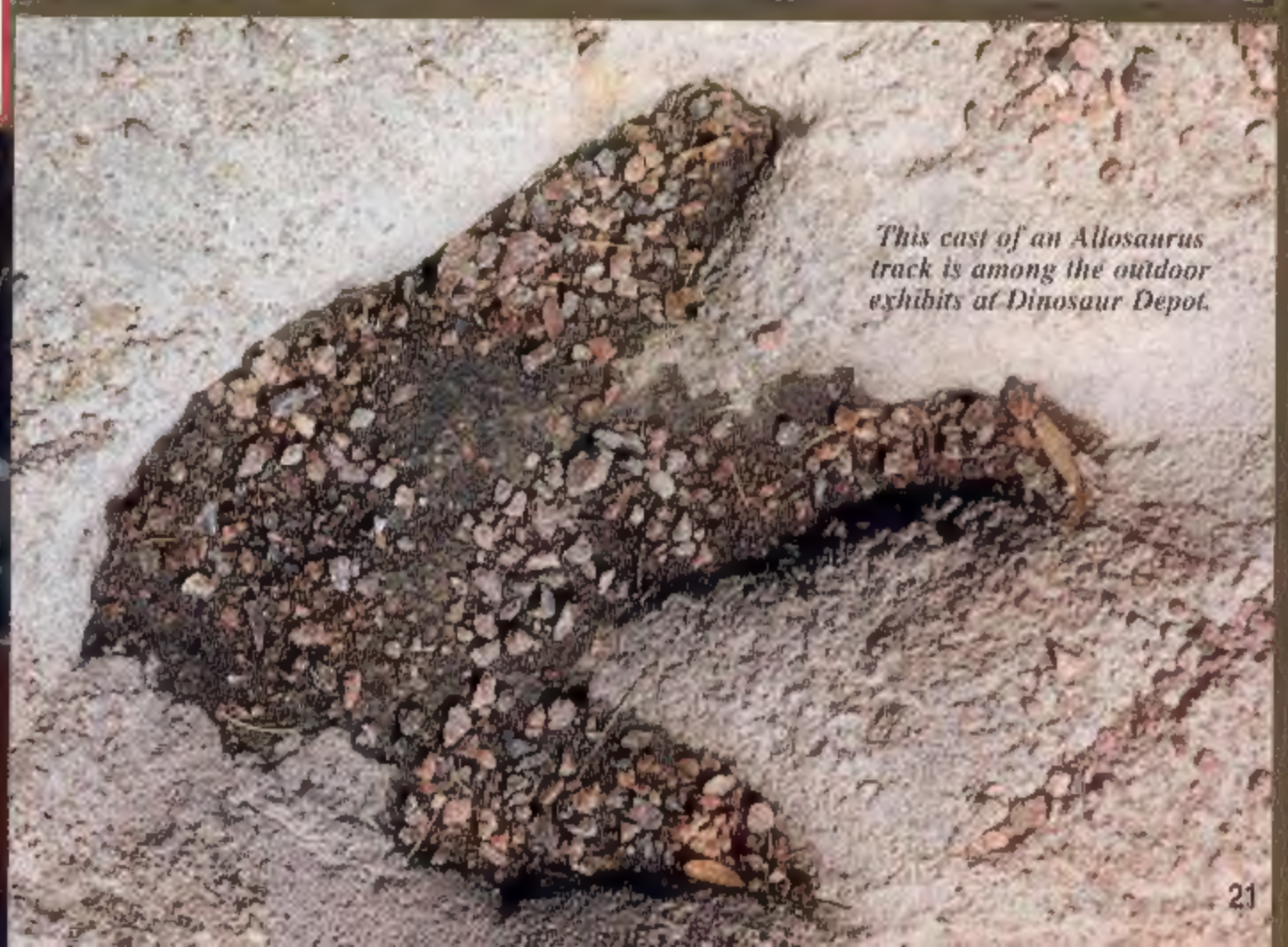


*This replica of the fossilized bones of a Stegosaurus recovered at Garden Park shows the original positions of the bones.*



*This cast of an Allosaurus track is among the outdoor exhibits at Dinosaur Depot.*

## The REAL Jurassic Park *from page 21*

In the 1870s, science still had only a murky understanding of the "monster animals" otherwise known as dinosaurs. European fossil excavations had already proved that dinosaurs had indeed existed, but the sporadic recoveries of incomplete skeletons and fragmented bones, rather than exciting scientists and the public, merely added to the confusion and misconceptions about the true nature of dinosaurs.

Felch's recovery of dinosaur bones in Garden Park coincided closely with another Colorado fossil discovery, this one 120 miles to the north at the tiny town of Morrison, not far from Denver. There, schoolteacher Arthur Lakes found a 14-inch-thick fossilized femur and a large vertebra in sandstone exposures. Lakes shipped his fossils east to America's most prominent paleontologists—professors Othniel Charles Marsh of Yale's Peabody Museum and Edward Drinker Cope of Philadelphia's Academy of Natural Sciences.

Marsh and Cope both rushed to Colorado, where they were stunned by the number, the remarkable level of preservation, and the completeness of the fossilized skeletons at Morrison. The sedimentary formation that yielded the fossilized bones was named the Morrison Formation after the little town where it was first described. The sedimentary record of a Jurassic-era lowland and swamp laid down between 155 million and 148 million years ago, the Morrison Formation extended over parts of a broad area from south-central Colorado north into Wyoming and west into Utah. Marsh and Cope quickly realized that searching exposures of the Morrison Formation was the key to additional dinosaur discoveries.

Meanwhile, Kansas State Geologist Mudge reported Felch's fossil discovery to Marsh, who led a field team to Cañon City. Marsh immediately recognized the Garden Park sediments as those of the fossil-rich Morrison Formation and, within days, made several new discoveries.

While Marsh was working at Cañon City, Cope moved north to Morrison Formation exposures at Como Bluff, Wyoming, where he also began excavating superb dinosaur fossils. Within three years, the fossils recovered at Morrison and Cañon City and at Como Bluff had given scientists and the public their first good look at the true nature of dinosaurs and had revolutionized the budding science of dinosaur paleontology.

Unfortunately, the relationship between Marsh and Cope rapidly deteriorated into a bitter professional rivalry that manifested itself in wild races for dinosaur fossils. In a spirited competition known today as the "Bone Wars," the professors employed competing teams of fossil prospectors and excavators across Colorado, Utah and Wyoming, ordering them to collect the biggest, best and most dinosaur skeletons for their respective museums.

Although Morrison and Como Bluff provided many spectacular fossils, they never quite matched the output of Cañon City, where Garden Park yielded 20 described genera and 19 species of fossil fish, turtles, crocodiles, dinosaurs, and mammals, and became the type locality for eight species of vertebrates, along with five dinosaur genera—Allosaurus, Camarasaurus, Ceratosaurus, Diplodocus, and Stegosaurus.

And the Garden Park excavations contributed more than fossils to paleontology. During the first excavations in 1877, S. Wendell Williston, a medical student turned amateur paleontologist, realized the difficulty of safely transporting heavy, fragile, fossilized bones. Drawing upon his knowledge of medical bandaging, Williston developed a method of encasing the fossils in alternating layers of burlap and plaster, an idea that led directly to the protective encasement techniques used by field paleontologists today.

Both Marsh and Cope excavated many specimens from Garden Park that became the core of the paleontological collections at two of America's most prominent museums. In 1882, Marsh reopened his original Garden Park quarry under the sponsorship of the U.S. Geological Survey. Within three years, he had shipped four of the most complete dinosaur specimens ever recovered at that time, including skeletons of Stegosaurus and Allosaurus, to the National Museum of Natural History (Smithsonian Institution). And shortly before Cope's death in 1897, New York City's American Museum of Natural History purchased his entire paleontological collection, which included many Cañon City dinosaur specimens.

Although the Bone Wars would end, the flow of fine specimens from Cañon City would continue. In 1915, local resident Dall De Weese discovered and collected a superb Diplodocus specimen, which paleontologists placed on display at the Denver Museum of Natural History (now the Denver Museum of Nature & Science).

Then in 1937, Cañon City high school teacher Fred Kessler and a group of his students found and excavated (with the help of Denver Museum of Nature & Science paleontologists) a nearly complete skeleton of Stegosaurus stenops. In testimony to the enduring importance of fine dinosaur fossils, the Colorado Legislature designated this same skeleton Colorado's official state fossil in 1982. And in 1995, paleontologists remounted the Stegosaurus skeleton in keeping with more contemporary behavioral knowledge of dinosaurs, making it a major exhibit in the Denver museum's outstanding and ongoing "Prehistoric Journey" exhibit.

During the 1950s, Cleveland Museum of Natural History paleontologists working in Garden Park unearthed a nearly complete skeleton of the previously unknown sauropod Haplocanthosaurus delfsi, making it a centerpiece exhibit at the Cleveland museum.

Oddly, despite its enormous paleontological significance over a full century, Garden Park continued to be known only to professional paleontologists and local fossil collectors. But after the federal government recognized the historic fossil locality as a National Natural Landmark in the 1970s, its fame finally began growing. In 1988, a group of Cañon City amateur paleontologists helped things along when they formed the Garden Park Paleontology Society and began publishing a regular newsletter, *Tracks in Time*.

More recognition followed when the U.S. Bureau of Land Management (BLM), which administers the land in Garden Park, declared the site an Area of Critical Environmental Concern and helped place it on the National Register of Historic Places. The BLM, together with the state of Colorado, also designated Garden Park a Research Natural Area.

Since the 19th century, Garden Park had produced a plethora of complete or nearly complete dinosaur skeletons, but all had been shipped to distant museums. In 1990, the Garden Park Paleontological Society took the first steps to keep some of its spectacular fossils at home. It acquired a 1930s-era fire station in downtown Cañon City and converted it to a paleontological preparation laboratory and museum called Dinosaur Depot.

Meanwhile, excavation activity in Garden Park picked up as Denver Museum of Nature & Science paleontologists returned for more fieldwork. This time, their results attracted worldwide attention.

In 1991, Denver museum paleontologist Kenneth Carpenter was collecting gastropod (snail) fossils at Garden Park when he found a well-preserved eggshell in a gray mudstone of

*continued on next page*

the Morrison Formation. When paleontologists found more fossilized eggshells, they named the site, which was centered around a 30-foot-high, eroded hill, "Egg Gulch." Within a year, paleontologists and volunteers had recovered 400 eggshell pieces, some as large as ½ inch, along with many tiny, fossilized, embryonic dinosaur bones.

While Cretaceous dinosaur eggs and eggshells are not uncommon, those of Jurassic age are unusual in the fossil record. Due to its biomineralogical composition and fragility, dinosaur eggshell is readily affected by both the local environment and diagenesis (changes undergone by a sediment after deposition), making it much rarer than fossilized bones and teeth. Paleontologists now recognize Garden Park's Egg Gulch as North America's oldest dinosaur eggshell site.

In the midst of the fossil eggshell excitement, paleontologists made yet another discovery—a skeleton of Stegosaurus stenops even more complete than the 1937 Kessler specimen. After three seasons of excavation, these Stegosaurus bones were finally removed in June 1995. The timing was perfect, since the BLM had just granted Cañon City's Dinosaur Depot museum status as a federal fossil repository, a legal technicality necessary to receive, store and display federally-owned fossils.

The plaster-jacketed Stegosaurus skeleton was Dinosaur Depot's first fossil preparation effort, a three-year project that was conducted in full view of museum visitors. When the job was completed, the prepared skeleton, weighing a ton and a half, was shipped to the Denver Museum of Nature & Science for permanent display.

Although professional paleontologists have made most of the discoveries at Garden Park, amateurs have also made many contributions. In 1998, Tony Moreno, a teenager on a school field trip from nearby Colorado Springs, discovered what appeared to be a fragment of petrified wood. As instructed, he reported his find—which turned out to be the exposed tip of a 20-foot-long, 150-million-year-old, fossilized tree trunk, the first major Jurassic plant fossil ever found in Garden Park. After excavation, paleontologists moved the sections of the fossilized conifer trunk, dubbed "Tony's Tree," to Dinosaur Depot for preparation and permanent display.

And in 1999, Cañon City resident William Kurtz discovered a set of never-before-seen dinosaur tracks. This time the discovery site was not at Garden Park, but on a near-vertical sandstone face along Skyline Drive within the town limits of Canon City. Based upon comparison of foot size and shape with tracks documented elsewhere, paleontologists believe that the ichnofossil (trace fossils) were made by a type of nodosaur some 107 million years ago and may represent a new trace-fossil ichnospecies.

Anyone visiting Cañon City's paleontological attractions should begin at Dinosaur Depot, which has emerged as an important regional paleontological museum and interpretive and educational center. Dinosaur Depot is owned by the Garden Park Paleontological Society and operated in partnership with the City of Canon City, the BLM, and the Denver Museum of Nature & Science. Located in the heart of Cañon City, it's easily identified by a 35-foot-long, lifelike, outdoor model of an Allosaurus.

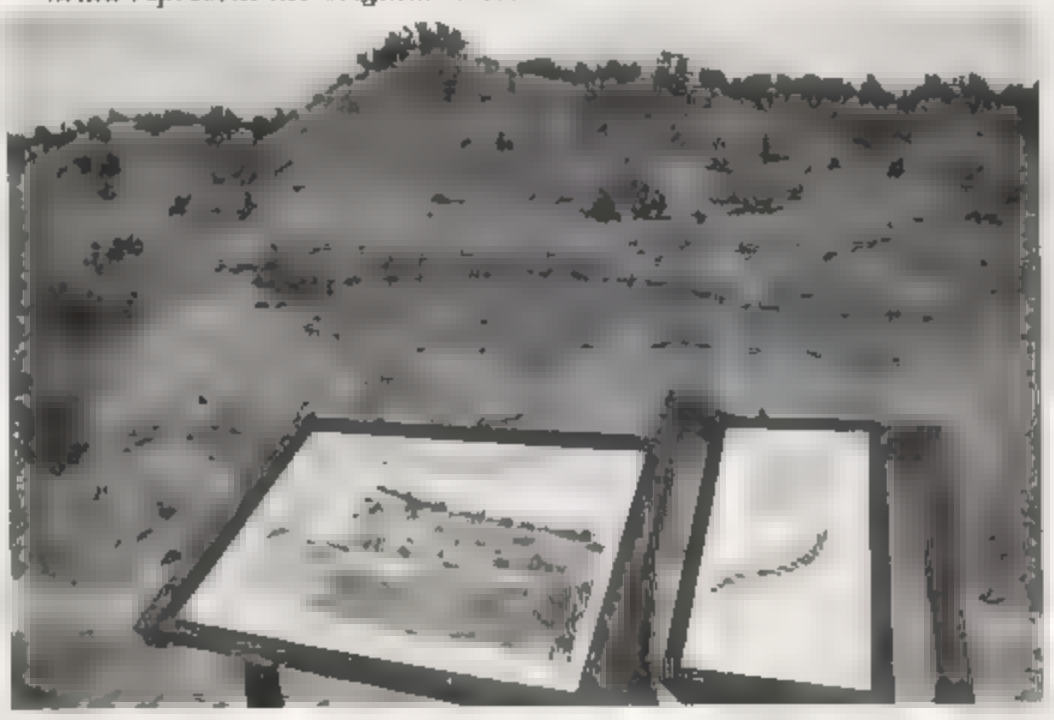
Interior exhibits include a replica of a fossilized Stegosaurus skeleton, a 5-foot-long fossil of an Ichthyodectes, a fish that inhabited the warm waters of the Western Interior Seaway which, in Cretaceous time, had its shoreline in the Cañon City area, a fossilized Diplodocus vertebrae: Tony's Tree, and informational displays about the early paleontologists Othniel Charles Marsh and Edward Drinker Cope, who worked at Cañon City more than a century ago.

Dinosaur Depot also has an outstanding museum shop that offers a wide array of dinosaur models and dinosaur related posters, books, and educational materials. While at Dinosaur Depot, pick up a copy of the *Self Guided Tour of the Garden Park Fossil Area* ($2) and the *Self Guided Tour of the Skyline Drive Dinosaur Tracks* ($1). These publications contain maps and background information needed for the short drives to Garden Park and Skyline Drive. Inquire also about museum sponsored guided tours to the Garden Park area.

The 3,600-acre Garden Park Fossil Area is eight miles north of Cañon City on Fremont County Road 9. The first stop overlooks an arid expanse of dusty arroyos, craggy bluffs, and jumbled boulders, which are all part of the fossil-rich Morrison Formation. Interpretive signs identify this site as the Cleveland/Delfs Quarry, the source of the huge sauropod Haplocanthosaurus delfsi, excavated in the 1950s and now displayed at the Cleveland Museum of Natural History.

A quarter-mile ahead, a stone monument erected in 1953 commemorates major Garden Park fossil recoveries. (The metal plaque erroneously states that a Tyrannosaurus had been excavated here, it was actually an Allosaurus.) At the stone monument, trails lead to the left and right. Both are easy, quarter mile-long walks up ravines and beneath sandstone bluffs. The left trail leads to Egg Gulch, where the Jurassic dinosaur eggshells were recently found. The right trail crosses several small wooden bridges near the discovery site of Tony's Tree, then follows a ravine to the place where Marsh performed his landmark excavations in the early 1880s. Interpretive signs explain the various points of interest. The existing trail system, made by volunteers, will soon be extended by two additional miles.

*The smooth area in the hill (top center) is the Garden Park fossil quarry worked by Othniel Charles Marsh in the early 1880s. The underlying strata represent the original stream bed in which the dinosaurs died.*



The Garden Park Fossil Area is located on land administered by the BLM, where federal natural area designations prohibit unauthorized collecting of any materials. Visitors to the Garden Park Fossil Area who do discover fossils should leave them in place and immediately report them to Dinosaur Depot or to the Cañon City Office of the BLM.

Dinosaur Depot, located at 330 Royal Gorge Boulevard (U.S. Highway 50) at the corner of Fourth Street, is open seven days a week from Memorial Day through Labor Day, then Wednesday through Sunday during the remainder of the year. Admission to Dinosaur Depot is $2 for adults and $1 for children ages 4 to 12. Children age 3 and younger are admitted free. The cost of museum-sponsored guided tours of Garden Park is $5 for adults and $2.50 for children. If the timing is right, you may even be able to observe fossil excavations in progress. For further information, call (719) 269-7150 or (800) 987-6379, or check out the Web site www.dinosaurdepot.com.

While there are many sites of paleontological interest in the United States, few combine the added element of paleontological history. Garden Park is not only a remarkable Jurassic-period fossil source, it's also one of the battlegrounds of the frontier-era Bone Wars and a place that contributed much to our early understanding of dinosaurs. And since paleontologists have thoroughly explored only about 10 percent of the site, important future discoveries are very likely, making Cañon City and Garden Park an unforgettable—and real—Jurassic Park.

# LAPIDARY LORE and MORE

by June Culp Zeitner

## Have You Hugged a Mineral Dealer Today?

Many hobbyists have somewhat antagonistic attitudes about gem and mineral dealers and other businesses that cater to rockhounds or amateurs in the earth sciences or lapidary arts. The truth is that today's high achievements by amateur mineral collectors and lapidaries are, to a great degree, due to these businesses. By and large, the people who went into the mineral, gem or jewelry business did so because they started as hobbyists and loved it so much that's all they wanted to do with their lives. They didn't go into business thinking it was a quick and easy way to wealth. They wanted to collect, prepare and display the crystals, gems or fossils they so admired, to associate with people of similar tastes, and perhaps to show some of the public the wonders of the mineral kingdom. And, they hoped that having their businesses would earn them enough to keep collecting, or to buy newer machinery or a wider variety of cutting material. A few have been successful beyond their dreams. Many are still struggling. But we couldn't get along without these businesses. Like the old saying, "It is a marriage made in heaven."

The lapidary hobby now has the best artists ever, but now would this have been possible without **Edward Acheson** and the business he founded in 1891? Acheson sent an electric current from a carbon electrode through a mixture of clay, salt, and powdered coke. After the experiment, he examined the end of the electrode with a big smile, I think, because what he found was some small, shiny, dark crystals, which (as he had hoped) proved to be extraordinarily hard. So he started the Carborundum Co. and manufactured the first silicon carbide. His first order was for 60,000 wheels. At that time, silicon carbide was next in hardness to diamond. In 1905, a scientist named Moissan found a natural mineral with the identical properties at Canyon Diablo in Arizona. It was named moissanite by Kunz and Dana. Was this the first time the synthetic preceded the discovery of the natural mineral?

David Jensen, a friend of mine from years ago, wrote an article titled "A Business that Started with a Pebble." It was a smooth, glossy pebble of dark gray gneiss, having been polished by a glacier. A 3-year-old boy picked it up, his name was **Henry Ward.** Soon he could put a label with it: "My first geological specimen." The boy grew up to establish Ward's Natural Science Establishment of Rochester, New York, in 1862. Ever since then, this business has supplied rocks, minerals and fossils to schools,

*Gem and mineral shows have advanced the hobby, the science, and the industry.*

universities, museums, and private individuals around the world. There were also meteorites, butterflies and bugs, as well as pictures, maps, books and slides.

Henry entered Williams College in 1851, bringing with him the usual freshman luggage plus boxes and boxes of self-collected rocks. Three years later, he became a lab assistant at Harvard to none other than Louis Agassiz.

Just before he started his business, he accepted a professorship at the University of Rochester. As a businessman, he claimed he only lost $1,000 on his first deal. It got progressively better, and soon he took a big exhibit to the Chicago World Exposition of 1893. He hired a freight train to deliver it to his 11,000-square foot exhibit area in Chicago. At the close of the Exposition, his exhibit became the nucleus of the Field Museum, now the home of my dinosaur friend, Sue.

**Arthur Montgomery** was the son of a successful New York businessman, who entered him in a private college prep school to start the study of accounting. Arthur had ideas of his own. He liked science, particularly geology, so when he entered Princeton in 1927 it was to get a geology degree. His work at Ward's Natural Science Establishment in Rochester convinced him that what he really wanted to do was to collect and sell fine minerals. He had great success in Utah, where he was in on the sensational Fairfield variscite finds. He also had good luck in Colorado and California. Then, he was able to buy part of the G. F. Kunz collection from Tiffany's. Soon, a list of museums, private collectors, and mineral businesses were waiting to see what he would come up with next.

The work was hard and often went from dawn to dusk, seven days a week. The accommodations were often primitive, to put it mildly, and he was usually far from help. I followed his adventures in print, the part that interested me most was his hunt for the incredible epidotes on Prince of Wales Island with his partner, Ed Over. Fogs are a daily event on the island and the legendary Green Monster Mine is rugged, remote and saturated with over 300 inches of rain each year. After several hazardous weeks, some of which were almost dry, the weather turned so bad that Montgomery and Over were lucky to make their way to the boat that was to take them to Ketchikan. But they were happy because they had found the bonanza epidotes. I bought a small one in Anchorage and saw the largest, most remarkable crystal cluster I could ever imagine at the University of Alaska Museum in Fairbanks. I like to think that this wonderful specimen may be one he dug out one gloomy day when it stopped raining at the Green Monster for a couple of hours, and what a thrill that must have been.

Perhaps we owe the most to **George Frederick Kunz,** who worked for Tiffany and Co. in New York. He was a mineralogist and gemologist and an avid explorer and discoverer of fine minerals. He sold several co-

lections to museums and universities. Although he studied and wrote about minerals, particularly gem minerals, from all over the world, it was his emphasis on U.S. localities that interested many people in the world of gems. He sponsored the adoption of the metric carat for weighing gemstones. He chose the names morganite and morrisonite. He championed America's freshwater pearls. He reported on Montana sapphires, Southwest turquoise and the diamonds found in Hall County, Georgia, as well as diamonds found in Wisconsin and Michigan. He wrote some reports for the U.S. Geological Survey, and studied the California pegmatites.

His tremendous volume of writing, especially his accurate, fascinating and well-written books, is a great part of the heritage of everyone interested in gems and minerals. Some of his books that are still important and widely read are *Gems and Precious Stones of North America*, *The Curious Lore of Precious Stones*, and *The Book of the Pearl*. He wrote *Gems, Jewelers and Ornamental Stones of California* for the California State Mining Bureau and *History of the Gems Found in North Carolina* for the North Carolina Geological Survey. His own extensive library was left to the U.S. Geological Survey. Kunz was given many honors, among the most lasting was the naming of the beautiful purple spodumenes, kunzite.

There are many other mineral businesses that have been of immense importance in advancing mineral collecting and lapidary masterpieces. To name a few that come to mind, **Gil Withers** started the first gem retail and wholesale business in the southeast in Atlanta. **Oeus Stanley** of Mount Ida, Arkansas, brought a truckload of Arkansas quartz to rock shops in the northern states every spring, and **Boodle Lane** of Kansas could be found standing in his yard full of tri-state specimens every summer. (We always bought from Oeus and Boodle.) One of the first dealers to give us a good start collecting in Maine was **Stanley Perham,** who had a mineral store at Trap Corner. **Herb Walters** did our first tumbling for us—50 pounds of select preformed pieces of Florida agatized coral. That was long before he started Crafstones, a business that has sold tons and tons of glistening tumbled gems around the world and instilled in many children a lifelong love of gems and minerals.

One of the best and most helpful mineral dealers I ever met was **Robert Dowell,** who gave up a successful accounting business to collect and sell gems and minerals and cast original custom made gold jewelry, which he set with fine gems. He sponsored field trips in the Rio Grande Valley agate and petrified palm locations, chaired a South-central Federation show, and took rockhounds to choice locations in Mexico for $80 a couple. He also took displays to every show he attended and sponsored classes and seminars.

So the next time you greet your favorite dealer, commercial collector, or manufacturer, please give him my regards, too.

# FOSSILS of INDIA

## These Ancient Creatures are Powerful Teachers

*Trilobite fossils, such as these from Russia, can be found in the Indian state of Kashmir. (Photos by Satyajit S. Gill)*

*by Brinda Gill*

*These fossils of Alectryonia, a bivalve, date to the Cretaceous Age, and were found in Trichinapally in South India.*

"In India, these black ammonites have been worshipped as a representation of the deity Vishnu since ancient times," said Dr. A.J. Vartak, showing us a whorled ammonite cast in black limestone. Dated to the Jurassic period, black ammonites are the casts of soft bodied marine animals of the class Cephalapoda, which became extinct along with dinosaurs at the end of the Cretaceous period, about 65 million years ago. Called salagrams in India, a body of legends has evolved around these revered fossils. Their spiral grooves are linked to the wheel, an attribute of the deity Vishnu. Furthermore, it is believed that their worship bestows fulfillment of desires — from the material to the spiritual — and that drinking water in which a salagram has been steeped possesses miraculous properties.

Dr. Vartak has been teaching geology at the Wadia College in Pune, India, for the last 23 years. During his research, as student and teacher, he has traveled across the Indian subcontinent to locate fossils, studied hundreds of fossil specimens, and shared his knowledge with fellow enthusiasts. Though ammonoids (which are important because they give age to the rocks in which they are found) are his focus of study, his collection includes other fossil types as well, both from India and abroad, that throw light on fossil groups of different periods. His informative and interesting collection has been valuable in instructing students and for research.

### GEOLOGICAL HISTORY OF INDIA

The Indian subcontinent can be divided into three physiographic regions: the Extra Peninsula Zone, the Indo-Gangetic Plains, and the Peninsular Shield. So far as stratigraphy is concerned, the peninsula is made up of very ancient rocks, the Archeans, dating to over 3,500 million years, and these rocks

*The fossil of a fungus gnat is preserved in amber, fossilized resin of coniferous tree form the early Tertiary period.*

*These impressions of sea urchins from South India date to the Cretaceous period.*

form the base for the deposition of younger sedimentary rocks above them. They are overlain successively by the Cuddapah Supergroup and the Vindhyan Supergroup. These rocks, better known as Pre-Cambrian rocks, form an important source of economically important mineral deposits, including iron, manganese, copper, diamonds and gold, among other ore minerals.

Above these Pre Cambrian rocks are the Gondwana rocks from the Permo Carboniferous to Jurassic periods, which are the main source of coal in India. The basalt rocks of the Deccan Traps, formed by fissure eruptions dated from the Cretaceous period to the Eocene epoch, spreading across a vast section of western and central India are the next rock formations. Under tropical or subtropical conditions, in some sections the rocks have been converted into bauxite deposits (which yield aluminium) or into laterite (used as building material).

Geologists have concluded India was once part of Gondwanaland (the name stems from an indigenous central Indian tribe called Gonds, who live in Madhya Pradesh), a huge land mass linked to Africa, South America, Australia, and Antarctica that was located in the Southern Hemisphere. The landmass of Eurasia stretched in the Northern Hemisphere, and the Tethyan Ocean separated these two supercontinents. Then, between 180 million and 140 million years back, Gondwanaland started fracturing. India separated from the landmass, followed by Australia and Antarctica, and slowly drifted northwards, ultimately colliding with Asia. The northern boundaries of India rammed under Eurasia, giving rise to the Himalayas, the earlier presence of the Tethyan Ocean along this belt is affirmed by the rich finds of marine fossils here. In India, the condition and quality of Himalayan fossils are the best, since they were preserved by the cold conditions. Tropical climatic conditions are not conducive to the preservation of fossils. The Himalayan mountain ranges form the Extra Peninsular Zone, and are mainly made up of sedimentary formations ranging in age from the Cambrian period to the Pleistocene epoch. The Indo Gangetic plains, which stretch below the Extra Peninsular, are of the Quaternary age and are made up of sand, clay and peat beds.

## FOSSIL FINDS IN INDIA

With belts of different types of sedimentary rocks (which are associated with fossils) occurring in different parts of the country, there are varied fossil finds in the Indian subcontinent. One of the most primitive life forms found in India is the trilobite, which lived in the sea from the Cambrian through the Permian period. The name trilobite indicates the division of an arthropod into three longitudinal lobes, a slightly raised central lobe, and two flatter pleural lobes on either side. In his collection, Dr Vartak has trilobites from northwest Russia and Czechoslovakia (dated to the Ordovician and Cambrian periods respectively). In India, trilobites are found in the Zanskar Valley in the northern state of Jammu and in Kashmir, as well as in the Spiti Valley, in the neighboring state of Himachal Pradesh. These two fossil belts in India have revealed finds dated to the Palaeozoic and Mesozoic periods. Due to political conditions in the states of Jammu and Kashmir, travel is restricted, which limits research of fossils in that region.

Dr Vartak has come across other invertebrate fossil belts in the Kutch region of the western state of Gujarat, where fossils of the Jurassic, Cretaceous and Tertiary periods have been found, which include fossils of bivalves, gastropods, ammonoids and echinoids. Digging in the Bagh beds in the central Indian state of Madhya Pradesh and in Trichinopoly and Pondicherry in the southern state of Tamilnadu has yielded finds of ammonoids, belemnites and brachiopods dated to the Cretaceous period, which indicates that an arm of the sea extended there during the Cretaceous period. Quaternary deposits have been located in sites along the west coast of India, probably indicating the earlier presence of mangroves.

*continued on next page*

## Fossils of India *from page 29*

To locate black ammonites, Dr Vartak trekked from Jamsom to Muktinath in Nepal, a mountainous country contiguous to India, at a height of about 14,000 feet His trip was sponsored by a religious person who wished to worship the fossils, and Dr Vartak was able to procure fine specimens of black ammonites, a few of which he has in his collection Though salagrams are found in Nepal, a similar strata stretches into India, along the Spiti Valley in the state of Himachal Pradesh, where these revered fossils have been unearthed During the trek in Nepal, Dr Vartak also came across fossils of belemnites, which belong to the class Cephalopod These specimens have been found in a limestone matrix as nodules, as well as in a "pen" form when the nodules are broken This group also became extinct at the end of the Cretaceous period

Moving onto vertebrate finds, the Gondwana sediments from the central Indian states of Madhya Pradesh and Andhra Pradesh, as well as the western states of Gujarat and Maharashtra, have yielded rich rewards to paleontologists The Siwalik Hills, along the foothills of the Himalayas, have also been a site for vertebrate fossils as best attested by the finds of well preserved specimens of the fossilized elephant Stegodon ganesa, which was probably the direct ancestor of the modern elephant Interestingly, a 2 annas stamp featuring this elephant was issued on the centenary of the Geological Survey of India, Jan 13, 1951, making India the first country to have issued a stamp of a fossil

Dinosaur fossils, including skeletal remains, eggs, coprolites (fossil dung), and footprints have been found in the states of Maharashtra at Pisdura, near Nagpur, Madhya Pradesh around Jabalpur, Ariyalur Group, near Kallamedu, Tiruchirapalli in Tamilnadu, and in the Godavari River Valley in the bordering areas of Andhra Pradesh and Maharashtra (where a near complete and well preserved skeleton of early sauropod Barapasaurus tagorei was unearthed)

Plant fossils are once again found in the Gondwana sediments in central and eastern India, in the Godavari River Valley in Maharashtra and Andhra Pradesh, the Mahanadi Valley in the state of Orissa, the Damodar Valley in West Bengal, and Wardha in eastern Maharashtra These include imprints of ferns on shale Fossilized wood, created by a "molecule-by-molecule replacement of organic matter by inorganic matter or minerals," is encountered in Cretaceous rocks around Ariyalur in Tamilnadu and in Jaisalmer in Rajasthan

### FORAYS IN THE FIELD

To study fossil deposits occurring in different parts of India, Dr Vartak has undertaken several field trips. These sites are chosen based on previous explorations that have located fossil rich areas and placed them on maps, or they are new sites that hold potential for yielding fossils The summer season (when the fields are fallow and have been furrowed in anticipation of the sowing season that commences with the monsoon), as well as the post monsoon period (when the rains have washed away the surface soil), are the best for seeking fossils He has traveled to Kutch in Gujarat, Trichinapally and other sites in Tamilnadu, Bagh beds in Madhya Pradesh, and to sites in Maharashtra as well as along the west coast to study fossils

Dr Vartak accompanied the Australian paleontologist Dr George Kendrich from the Western Australian Museum twice on trips to fossil sites in south India, and has accompanied British paleontologist Dr Paul D Taylor of the British Natural History Museum, on a trip to fossil sites in Tamilnadu in 1993 Dr Taylor had made an earlier trip to India in 1991 to collect specimens of bryozoans (creatures that have a history going back to nearly 500 million years into the Ordovician period from rocks about 70 million to 100 million years old, which were seen on a Coraline Limestone, dated to the mid-Cretaceous period, found in the Bagh beds

In the chapter "Two passages to India" of the book *Travels with the Fossil Hunters* (2000, Cambridge University Press), Dr Taylor writes that the bryozoans collected from the Bagh Group turned out to be a new genus, which he and his geological companion named Chiplonkarina in honor of the late Professor G W. Chiplonkar, who had worked extensively on the fossils of the Bagh Group and other Indian Cretaceous rock He explains that Chiplonkarina is an extreme example of homeomorphy, whereby different groups evolve similar colonial architectures independently, repeating a successful design for living The trip yielded finds of bryozoans, brachiopods (lamp shells), bivalves (cockles and their relatives), and echinoids (sea urchins) Of these Dr Taylor remarks that "Perhaps the most striking fossils were the echinoids that weather out in great numbers at some localities A local tribesman who crouched down beside us at one locality already knew of their presence in the rocks and even had a name for them panchu khada, meaning five-stone, an allusion to the five radiating 'ambulacral' rays on the surfaces of the fossils that mark the position of the tube feet in the living creature"

*These Cretaceous-period ammonoids were discovered in South India*

Dr Taylor's second trip was to the Cauvery Basin in Tamilnadu in 1993, to the largest of three patchy Cretaceous outcrops around Ariyalur The trip yielded rich finds of well preserved marine fossils The team also visited Dalmiapuram, a town centered around a cement manufacturing plant where limestone quarries are blasted for material, and fossils are relatively easily located in the rubble Of the finds, Dr Taylor writes that most of the fossils consisted of a wide range of invertebrates that had inhabited the shallow Cretaceous sea including sponges, corals, brachiopods, molluscs, echinoids, belemnites, ammonites and bryozoans The team was "successful in discovering the first unequivocal bryozoans to be found in the Uttatur Group They consisted of small dome-shaped colonies less than a centimeter in size Among them is a species belonging to an unusual extinct group of cyclostomes called melicertitids that had never been found outside Europe, thereby considerably extending the geographical range of these animals and proving that they spread south of the equator during Cretaceous times"

The Trichinapally area is where Dr Vartak undertook field trips to study ammonoids for his Ph D His doctoral research was a part of the project "Revision of Cretaceous of India," which was started in 1971 under the guidance of the late Prof G W Chiplonkar and R M Badve, and later he worked under Dr M A

*continued on page 32*

# Fossils of India *from page 30*

Ghare Dr M V A Sastry and Dr W A. Conban examined the thesis.

Dr Vartak studied heteromorphs, which are ammonoids with shells deviating partially or completely from a plane spiral, differing from the standard type or form He selected ammonoids for study because research indicates that because of their rapid evolution, abundance, and widespread distribution, they are the most valuable of all fossils for zoning the rocks in which they occur

During the trips, Dr Vartak studied and collected heteromorph ammonoids, the fossils principally covering the Utatur Group, which gave the best yield and then the Trichinopoly Group and the Ariyalur Group, which gave a limited yield Heteromorph ammonoids constitute an important group, which became highly diversified before the extinction of ammonoids Dr. Vartak's research and findings reported a new genus, Neopty choceras, of the superfamily Ancylocerataceae, from the Utatur Group Of the superfamily Turrilitaceae, two genera, namely Diplomohamites and Glyptoxohamites, occur in the Utatur Group and in shell limestone Seventeen species reported elsewhere in the world now were reported to occur in South India, and Cretaceous deposits were found for the first time Among the heteromorph ammonoids, three genera and seven species reported in the present work are new to science

## OTHER FOSSILS

In addition to taking field trips, Dr Vartak also interacted with paleontologists from India and abroad, who have sent him information and specimens In 1998 he attended the International Cretaceous Seminar in Chennai, India, and worked with Professor Hancock from the United Kingdom who later sent him an interesting treatise on Cretaceous ammonoids Among the fossils from abroad are two small fossils—one of a fly and the other of a fungus gnat preserved in Baltic amber Amber is a fossilized resin (hardened resin, called copal, slowly turns into amber) of a coniferous tree of the early Tertiary period Animals falling into resin, which is extremely sticky, get preserved as fossils. The amber from the Baltic Sea is famous, as many organisms rarely found elsewhere in the world from the Tertiary period (about 60 million years ago) are fossilized in it Though there have been finds of amber in India, in the Kutch area, so far there have been no finds of fossils preserved in such amber Another set of fossils from abroad is of brachiopods from Poland, dated to the Paleozoic era

From the United States, Dr Vartak has a fossilized fish from Wyoming, preserved in limestone dated to Eocene epoch, as well as shark teeth dated to the Cretaceous period Ammonoids from abroad include specimens from France, Germany, Russia, Nepal and Australia Belemnites from Germany and Nepal, bivalves and gastropods from Poland, and Echinoids from Texas are the other prized fossils Adding to his collection of fossil finds, Dr Vartak also has more than 200 stamps featuring prehistoric animals, which has got his name entered into the Limca Book of Records, an acknowledged publication of record holders in India

## AN INSIGHT INTO EVOLUTION

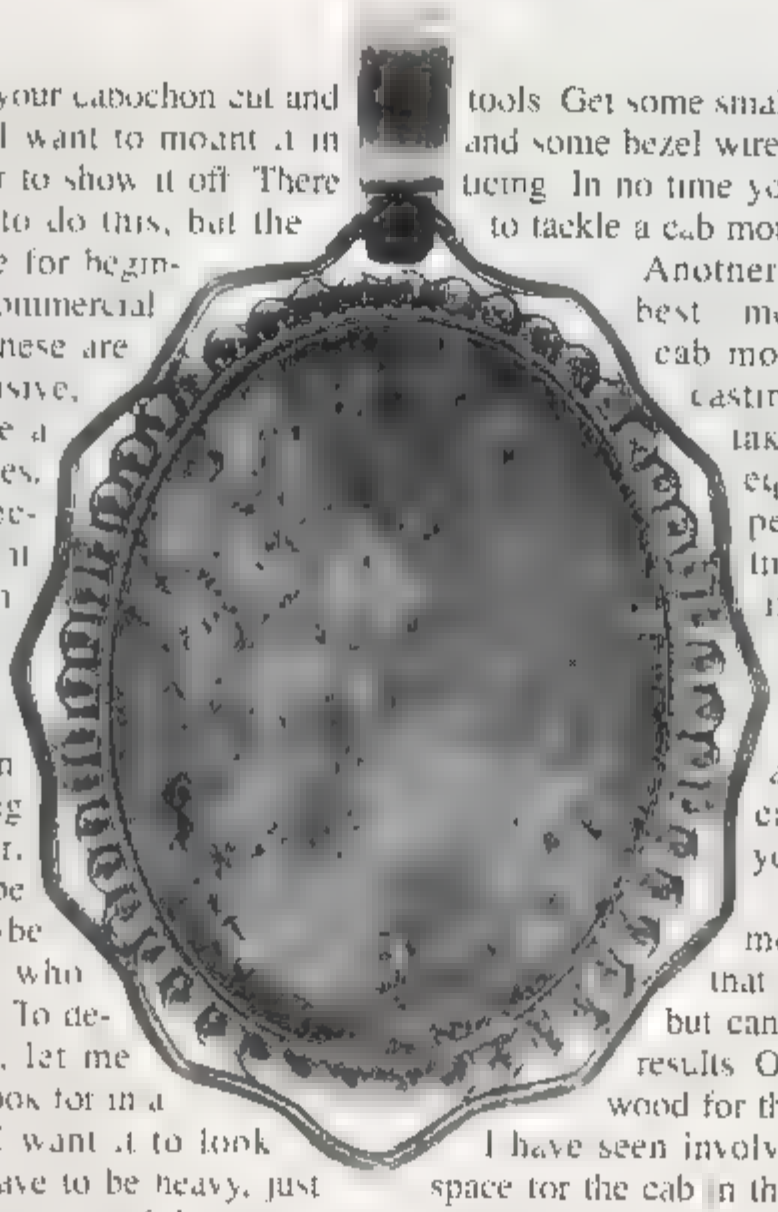
Dr Vartak has reported his findings to headquarters of the Geological Survey of India in Kolkata, as is the standard procedure for recording fossil finds in the country He observes that fossil finds yield several inferences Dr Vartak says that they are reliable age indicators, and as they give a definite age to a rock, they have helped correlate widely separated rock formations The similarity of the plant fossils found in the Permo-Carboniferous coal seams of India, Australia, Antarctica and eastern South America has helped reconstruct the presence of Gondwanaland

Dr Vartak remarks that the characteristics of fossils found in different geological conditions are often suggestive of varying environments, the presence of vertebrate fossils and plant fossils indicate a terrestrial environment, while the presence of nautiloids, ammonoids and corals indicate a marine environment The presence of terrestrial and marine species in the same beds suggests a near-shore or shallow-water marine environment "By comparing and correlating the present living forms with the marine fossils forms, it is possible to decipher the exact depth of the sea in which the bed was deposited. For example, the presence of borings [cavities], created by bivalves and gastropods, in older rocks indicates shallow-water deposition, as borings are still observed in shallow water environment Further, modern-day discoveries of petroleum have been possible with the help of micro fossils, like Foraminiferas, which are indicative of the presence of petroleum" Thus, the study of fossils in India, tells us about the history of the land, its relation with other regions, and the presence of associated minerals that may occur along with them

# SHOP TALK

by William A. Kappele

# Cab Mounting: Finding The Right Findings



Once you have your cabochon cut and polished, you will want to mount it in something in order to show it off. There are lots of ways to do this, but the most common one for beginners is to buy a commercial pendant mount. These are plentiful, inexpensive, and come in quite a wide range of styles. My primary objection to them is that too many of them *look* inexpensive (cheap).

Now, these findings have been around for as long as I can remember, so someone must be buying them. Maybe I'm the only one who isn't fond of them. To defend my position, let me talk about what I look for in a mounting. First, I want it to look heavy. It doesn't have to be heavy, just look it. For example, most of the inexpensive mounts are stamped rather than cast or fabricated. The design is just pressed into thin metal. Usually, this makes the detail less sharp and the edges very thin. In addition, the bezels are almost always a very thin strip of metal with a sawtooth edge.

Now that I have irritated all of the good people who make these findings and those who really like them, let me say that beauty is in the eye of the beholder, so if you choose to buy commercial findings, get what you like and ignore me. (You won't be the first.) For those of you who agree with me, take heart. There are really nice findings out there at reasonable prices; it just takes a lot of looking to find them.

If you can't find any that you like, you have the alternative of making your own. You don't have to be a silversmith to make beautiful, simple, classic cab mounts that will be worthy of the best stones you cut and polish. The most common way to proceed is to form a bezel around your stone, cut it to length, and solder it to a silver backing sheet. Get a book on silversmithing (our advertisers carry a number of them) and read up on silver soldering. It is not difficult and requires just a few tools. Get some small pieces of flat silver and some bezel wire and do a little practicing. In no time you will be competent to tackle a cab mount.

Another (and perhaps the best) method of making a cab mount is by lost wax casting. This, of course, takes more tools and equipment, more expertise, and more time, but you can do it if you persevere. If you are not an artist, there are many wax patterns available that you can use or adapt to your needs.

There are several mounting methods that are less often used, but can lead to spectacular results. One of these is to use wood for the mount. A method I have seen involves hollowing out a space for the cab in the center of a highly figured piece of wood. In effect, you inlay the cab into the wood. The outer portion of the mount can be treated in the way that will accentuate the pattern best.

Finally, don't overlook the use of wire wrapping for mounting your cabs. Although a standard flat backed cab can be mounted this way, it is the double cab that really profits from wire wrapping. Finding a mount for a double cab is difficult, but wire wrapping will allow the stone to swing on a necklace chain, and no matter which side shows, it is beautiful. There are many books on wire wrapping, but I am prejudiced toward *Contemporary Wire Wrapped Jewelry*, by Curtis Leonard and William Kappele (Gem Guides Book Co., 1995). Many of our advertisers carry it.

As with all aspects of the hobby, let your imagination be your guide. If we all went by the book, we would still be bonking each other on the head with clubs.

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappele@cox.net, or write to me at 25231 Patricia Dr., Mission Viejo, CA 92691.

# GEMOLOGY:

## Learning the Craft

# Part IV: Weights and Means

*by Douglas S. Le Grand, G.G.*

Sometime around 224 B.C., King Hiero of Syracuse had a golden crown made for him. Being a king, and not a trusting one at that, he wanted to test whether the crown was indeed pure gold as the jeweler had promised him. A young mathematician by the name of Archimedes was chosen to test the crown. The king also told young Archimedes that he was not allowed to mar the surface of the crown in any way. This meant that none of the standard tests commonly used in those days could be used on the crown. Archimedes was stumped; he had never come across a request like this and did not know how to commence testing the crown.

Sometime later, while sitting in his bath, he noticed something: his body became more buoyant the deeper he sank into the water. His reasoning was simple: the buoyant force of the water on his body was equal to the weight of the water it displaced. He figured that a body immersed in water loses as much weight as the weight of the water it displaces. It was this discovery that he applied to the task at hand. It is also the principle that we are going to learn about as applied to the testing of gemstones. When we measure the density of a material, we are measuring the relative density of a material as compared to water. Specific gravity is a ratio, not a weight.

In this article, we are going to learn about identifying characteristics other than optical characteristics. These items are specific gravity (SG) and the streak test. Although using liquids to perform an SG test is pretty inconvenient while on the road, it can be very useful in separating certain stones. The streak test, on the other hand, is very simple and convenient to use.

Every element found on Earth has a unique specific gravity in its pure state. Let's take a well-known gem mineral like corundum ($Al_2O_3$). It has a hexagonal (trigonal) crystal structure and a specific gravity of 4.00 (+.10, -.05). This means that this stone will weigh four times as much as the water it displaces. Now, in real terms, how do we find the exact weight of the water it displaces?

The Hydrostatic Method is the best known and most commonly used. The best way to accomplish this is to first use an accurate scale to weigh the gemstone. This is the weight in air. Next, we weigh the gemstone while freely suspended in water; this will be our weight in water. It will weigh just as much less in water as the water it displaces. Let's take our corundum gemstone as an example. In its pure state, corundum's SG is 4.00. Ruby and blue sapphire's colors are caused by different trace minerals, and the deeper the color, the greater the difference in SG. These trace minerals will not throw the gemologist off track and our measurements will be close enough, but it is fun to imagine that you could measure the difference between the two gemstones simply by the amount of chromium or tin or titanium in the stones' atomic structure.

For example, if we wanted to test a 12 carat blue sapphire, the weight in air is exactly 12 carats. We then test the weight in water and find that the stone now weighs 9 carats. The difference is

the weight of the water that is being displaced; subtracting 9 from 12 gives us 3. Specific gravity is a ratio that represents the relative density of a material when compared to water. To find SG, we divide the weight of the gemstone in air by the difference between the weight in air and the weight in water: 12 – 9 = 3, 12 ÷ 3 = 4.0. If you check your chart, you will see this gives us the SG of corundum.

For the pure scientist, there is another variable, the temperature of the water. Water at 39 degrees F (4 degrees Centigrade) has an SG of 1.0, or unity. This is the standard that scientists will use as a universal measurement. This is also the temperature at which water is its densest. Let's say your lab temperature is not set at 39 degrees F, but at a more humane level of 70 degrees F. The density will drop to .998. To find the correct value, we would multiply 4.0 by .998 and get 3.992. But for all intents and purposes, let's not worry about the .002 and leave it as 4.0.

You might be wondering why I would go into such extreme detail as the temperature of water. That's simple. We can use other liquids to measure our specimens, and knowing that, there is a simple math formula to use. We can just add a correction factor. An example is carbon tetrachloride, whose SG is 1.59. Multiply the SG arrived at above by the SG of carbon tetrachloride to get the corrected SG: 4 x 1.59 = 6.36.

A word of caution. For testing stones less than ½ carat, it is advisable to use a liquid with low surface tension like carbon tetrachloride. A simpler approach is to use a liquid soap to break this surface tension. You don't even need to use a correction factor when using soap, a better deal all around.

## THE HYDROSTATIC METHOD

Now you're asking yourself, where do you find a scale to measure a gemstone in water and how do you use it if you find one? Both questions are very commonly asked and will be answered here. This part of the lesson is about using the hydrostatic method. The hydrostatic method uses a diamond balance or any other accurate scale. It is just a simple balance beam scale with a few modifications that allow us to measure the stone in water and in air.

Start with an accurate balance beam scale. Cut a length of light stainless steel wire with a hook on one end to hang from the left pan support. Twist the lower end of the wire to support the stone. Cut another length and twist its end to act as a counterweight for the right side of the scale. It is critical that they are balanced and equal in weight. Use any small container that will hold a cup of water and a small bracket to support the beaker. A simple "C" bracket can be made out of a scrap piece of stainless steel or aluminum. Its base lies flat under the left pan and the top supports the beaker just above the pan. The bracket must be high enough so that the balance pans do not touch the beaker.

It is time to balance the scale, fill up the jar with water, place the wire in the beaker, and hang the counterbalance wire on the right hand side. The scale should zero out exactly. If it does not, cut the counter wire until it balances exactly with the left hand side wire, which is submerged in the water.

We are ready to begin. First, we want to weigh the stone in air. Place the stone in the left hand balance pan and get an accurate measurement of weight. Let's use the same piece of corundum we had before. Testing it, we see that it weighs 12 carats in the air (pan). Second, remove the stone from the pan, place it in the wire basket we made out of stainless steel, and lower it into the water slowly. Be careful that it is not touching the sides or the bottom of the beaker, and make sure that it is completely submerged in the water. Weigh it carefully, you should get a reading of approximately 9 carats. Third, going back to our formula, we subtract the weight in water from the weight in air. This gives us 3 carats, the weight of the water that is being displaced by the stone. Divide the weight in air by the difference of 3, and this will give us the specific gravity.

A similar scale can be set up using a balance beam scale. Set the scale up on a cardboard box and hang our basket from the left arm through a hole cut in the cardboard box. Also remember to use a counterweight for the right arm. Use the same technique as was used with the diamond balance beam scale to obtain the SG with our homemade scale. With a little practice, it is amazing how many stones you can identify with this tool. As you can readily see, it is a tool that is best left at home in your lab and not something you can expect to carry with you in the field.

Another problem with using the diamond beam scale is its inaccuracy with stones weighing less than ½ carat. This problem is due to the surface tension of water, which can be quite considerable. To overcome this, we can use carbon tetrachloride. When using a liquid other than water, a correction factor must be used. In this case, carbon tetrachloride has a SG of 1.59 and so this is our correction factor. One extra step must be taken to end up with the correct SG. If the stone's weight in air is 12 carats, the weight of the stone in carbon tetrachloride is 7.23. Twelve minus 7.23 equals 4.77. Twelve divided by 4.77 equals 2.51. The last step is to multiply 2.51 by the correction factor 1.59, which gives us 3.99.

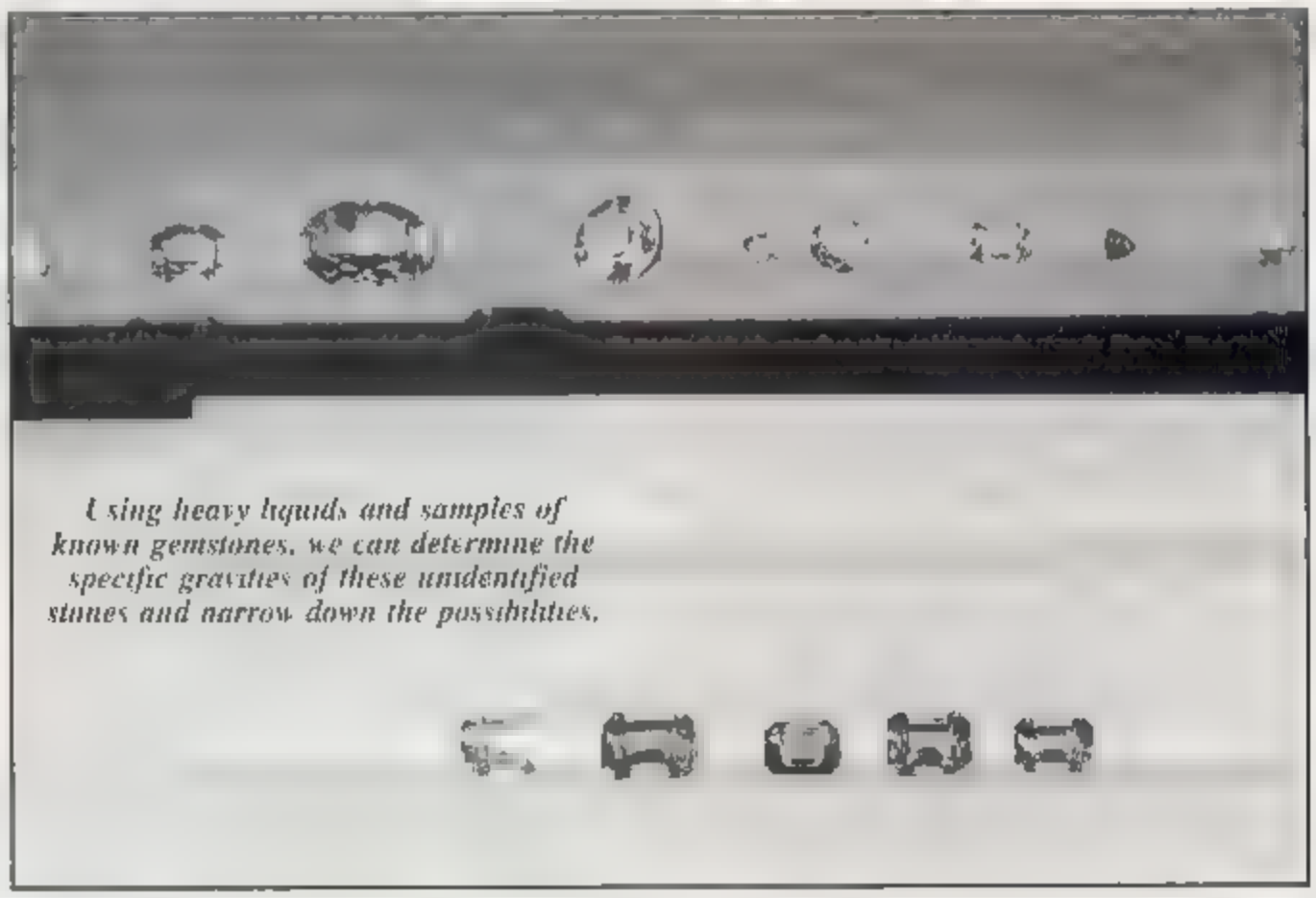
If you are out in the field, obviously you can't carry around a diamond beam scale. What are you going to use? The best way to determine the SG of a mineral in the field is to use what are called heavy liquids. They are convenient, safe, relatively easy to use, and pretty accurate. Using heavy liquids is simple. Set the stone in the solution gently. If it sinks, it is heavier than the liquid, if it floats, it is lighter. You will also note how quickly the stone drops or settles on the bottom, and how quickly the stone floats to the surface when you push it down.

*continued on next page*

The two most common liquids used in gemology are bromoform, with an SG of 2.90, and methylene iodide, with an SG of 3.32. Either can be diluted with xylene for a specific SG. As you can guess, determining specific gravity using liquids is a hit-or-miss proposition, as you cannot reach an exact SG. It is not accurate by any means, but useful as a quick identification tool. With practice, you will be able to determine the specific gravity of most gemstones. It is important to point out that you should let the laboratory supply house where you plan to purchase the liquid know that you are using the liquids for mineral identification, because there are a lot of different liquids that can be used and most are not suitable for gemstone identification. Actually, any liquid other than water can be used if you know the SG of that liquid, but most are too expensive or dangerous to use. You can set up a lab with many minor gradient differences in SG, but why do it? Most labs use two different SG levels, three at most.

Let's say I have a mint green stone. Using my pen light and looking through the stone at the light bulb, or using my light box, I have determined that it is in fact double refractive, so I am not thinking about a garnet or glass, but wonder if it is a peridot or tourmaline. Sea-foam green tourmaline was a hot item with all the designers last year and carried a premium price tag of around $30 per carat—about right for peridot, but quite low for fine sea-foam green tourmaline. Both stones have a very close R.I. My next test would be to find out the SG of the stone in question. With only two heavy liquids, I can quickly and simply separate the identity of the gemstone. For this test I use methylene iodide, with an SG of 3.32, in its undiluted state. I can determine if a lime green stone is a tourmaline or a peridot. Tourmaline (SG 3.06) will float lightly above the surface in SG 3.32 liquid. If I push it down to the bottom, tourmaline will rise slowly, while peridot (SG 3.34) will drop to the bottom slowly. If the liquid is a little off and the stone floats, push it down with your tweezers. If it is peridot, it will stay on the bottom, while tourmaline will rise. When gauging SG in heavy liquids, it is the speed with which the stone drops or the level at which it floats that helps you determine the SG.

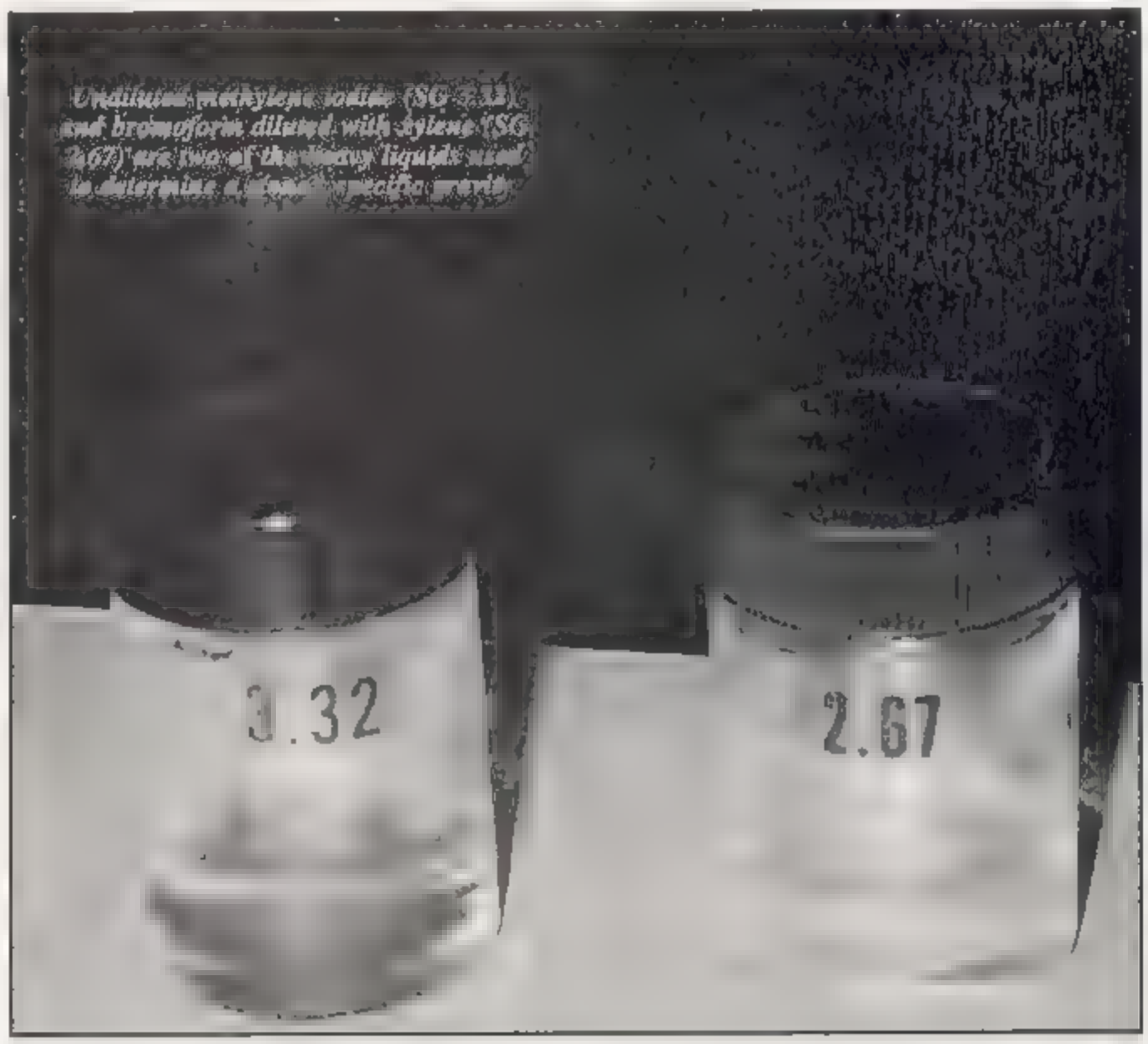
If you place a diamond into a jar of bromoform diluted with xylene to an SG of 2.67, or more commonly, acetylene tetrabromide (SG 2.96) diluted to an SG of 2.90 or 2.92, the stone will drop quickly to the bottom of the jar. Set the same stone in a jar of undiluted methylene iodide (SG 3.32) and the diamond will drop very slowly until it settles on the bottom. Diamond has an SG of 3.52, so it is slightly heavier than the liquid, but not twice as much as with the other solution. So, as with all the other tools, it takes practice. When I say practice, what I mean is to take several stones of known identity, set them in corrected heavy liquid, and notice how they sink or float.



*Using heavy liquids and samples of known gemstones, we can determine the specific gravities of these unidentified stones and narrow down the possibilities.*

Another liquid that is handy is saturated salt solution (SG 1.15) for identifying amber (SG 1.08). If it is truly amber, it will float in salt water, that is how it is actually harvested. After a strong storm in the Baltic Sea, amber is broken off the sea floor and floats to land. The amber hunters get up early and go out for their morning gem hunting walks, and pick the material off the beach. If the material presented to you is plastic (SG 1.30 ± .25), it will sink to the bottom of the salt solution. If you heat a safety pin with your lighter and touch the amber in a place that will not show, you will smell a resinous odor, if it is plastic, you will be able to tell quickly from its acrid odor.

The floating test will not help you separate amber and copal. Copal is a fossil




*Undiluted methylene iodide (SG 3.32) and bromoform diluted with xylene (SG 2.67) are two of the heavy liquids used to determine the identity of gemstones.*

resin like amber, but of lower quality and not nearly as old. Amber is usually 300 million years old while copal is less than 20 million years old; amber is impervious to acetone, while copal reacts quickly.

When you set up the solution, test it with a known piece of amber to make sure you have a high enough level of saline in the water. The range of natural gemstone SG is limited to between 1.08 for amber and 6.95 for cassiterite. There are several heavy stones in the 4.0 to 5.0 range, such as sphalerite, zircon, spessertite (one of the heaviest in the garnet group), and corundum (all colors), but the majority (over 75 percent) of all the gemstones listed are in the 2.0 to 4.0 range, hence the use of 3.30 and 2.67 liquids.

There are still special requirements for the selection and care of heavy liquids that you will be using in determining the identity of gemstones. Most people will simply go out and purchase the heavy liquid test kit. This is a good and simple way, but what happens when the liquids lose calibration? These liquids are diluted with xylene. Xylene evaporates, and this changes the SG of your solution. There are usually three heavy liquids being used in gem labs today, methylene iodide (SG 3.30 to 3.32), bromoform (SG 2.89 to 2.90), and bromoform diluted with xylene (SG 2.62 or 2.90). The methylene iodide is by far the most commonly used. Bromoform has become expensive and difficult to obtain and has been replaced with acetylene tetra bromide (SG 2.96). Acetylene tetra bromide has all the advantages of bromoform with none of its disadvantages: It is easily diluted, less expensive, and does not turn black as quickly in strong light. It can be diluted with xylene to SG 2.62.

To calibrate your mixtures, you will need indicator strips or standards. Most solutions are calibrated with two different standards, one should sink and the other should just begin to float. When the heavy liquids are out of calibration, both strips could be floating or both lying on the bottom of the jar.

Sometimes bromoform can be purchased from chemical warehouses, but it has been diluted with alcohol. Alcohol makes the heavy liquid unstable. The best method to remove the alcohol is to wash it out with water. This process leaves the bromoform with an SG of 2.90. Put equal amounts of bromoform and water in a container, shake it for 30 seconds, and let it stand. It will separate easily, with the water/alcohol on the surface and the bromoform on the bottom.

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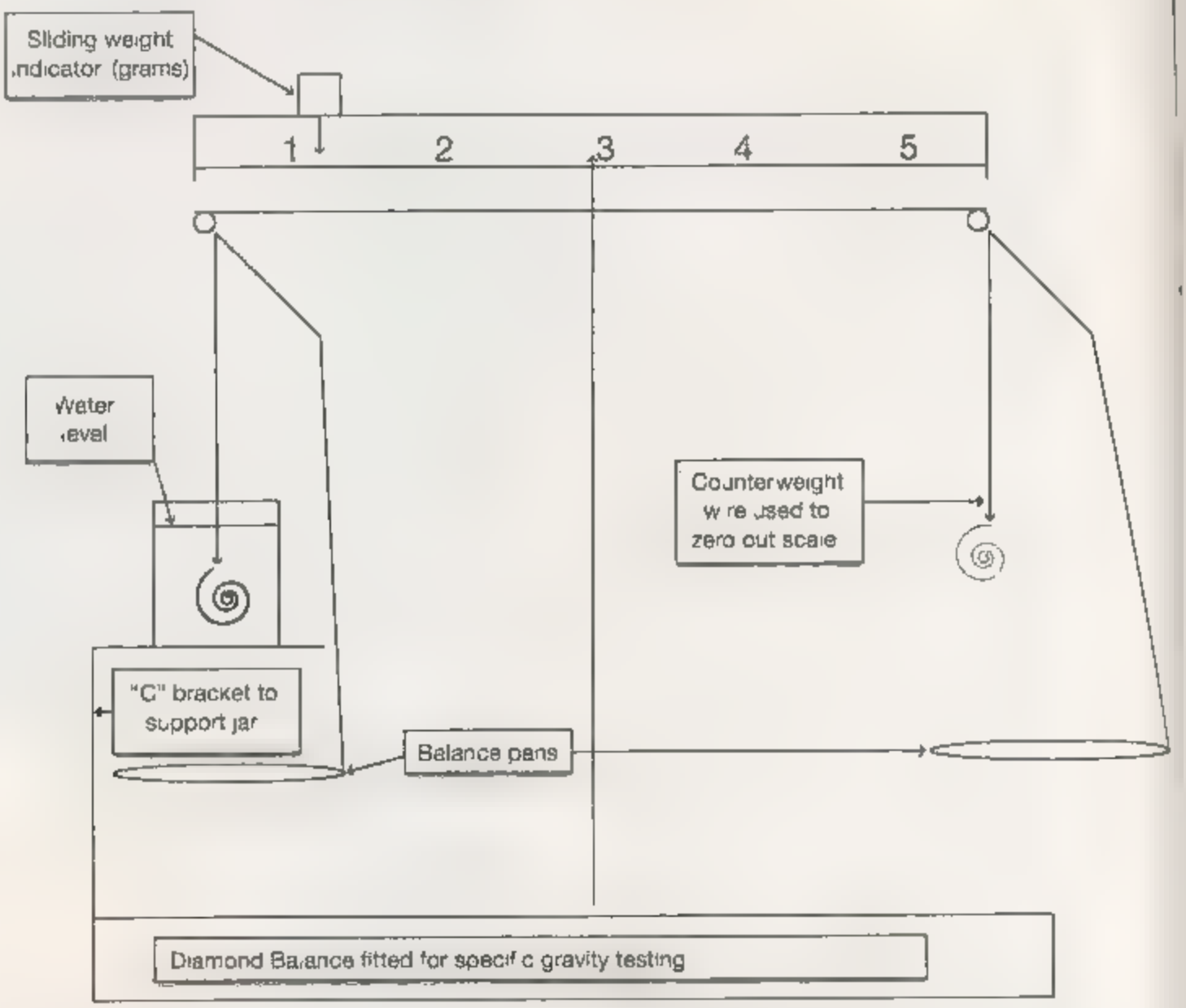
# Gemology: Learning the Craft *from page 43*




Repeat this several times and then run the bromoform through a chemist's filter to remove the last of the water.

When using bromoform and acetylene tetra bromide full strength, you will not need indicators, but if you dilute them to a lower SG, you will. If you lower the SG of heavy liquids to 2 62, you will want to have two slices of stone, one of quartz crystal and one of chalcedony When the liquid is of the correct calibration, the crystal quartz will sink and the chalcedony will float. If the liquid becomes too heavy, the quartz crystal will float If this happens, it is easily corrected; just add a few eyedroppers full of xylene It will lower the SG again to 2 62 Remember to stir the mixture up with each drop of liquid added

If you get overly excited and add too much xylene, again this is a simple process to correct. Just leave the lid off the container and allow the xylene to evaporate to raise the SG slightly. Never use alcohol as a diluent. It will evaporate too quickly to be useful in our business.

A word of caution Most of the chemical liquids that have been discussed so far will darken if left out in bright sunlight. I recommend closing the lids as soon as you are finished testing a stone and placing the vials back into their respective boxes or case Another word of caution, when you set your stone in one solution and you wish to retest it in the other solution, wipe the stone clean before transferring to the next solution

This will keep your heavy liquids calibrated for a longer period of time and reduce cloudiness If after many uses you notice a film or sediment in the bottom of your jars, use a common chemical paper filter that you can purchase at any chemical supply house and run the liquids through the filter This should restore your liquids to pristine condition.

Standards are necessary for all diluted mixtures, they can be purchased or made at home by a simple process that I read about in other lapidary books. I have suggested using stones that are of a known SG; this is easily done with a little homework. Another simple and effective method is to epoxy together two different pieces of glass or different minerals with different SGs Then grind one or the other down until you have the desired SG indicator

Another rather crude, but effective, tool is your own hands This is called the "heft test." Many gems can actually be discerned by the heft of the stone If you don't believe it, here's an example, when you do your 20-stone gem exam for the G.I.A., you might have a stone that is so small that you cannot do any other test except the heft test This is true and a good reason to practice the heft test A good standard is pyrite, with an SG of 5.0. Carry that around with you on your buying trip and use it to compare similar sized stones If you happen to find a nice piece of sphalerite, it has the same SG as

*continued on page 90*

# Catch-and-Release Collecting

*by Mary E. Garatti*

Here's something to ponder: catch-and-release mineral and fossil collecting. I'm serious. Sportfishers have been employing catch-and-release in their hobby for decades. Hunters, too, often pass up legal game in pursuit of better quarry. In fact, most hobbies that involve the harvesting of natural resources have bag limits of some type. Maybe it's time ours did, too.

While on a recent fossil-collecting trip to Nevada, my friend and I decided to collect only every third piece of material we found. We did this so that those who arrive after us, whether the next day or the next century, will have an opportunity to enjoy the hobby, too. I admit it was difficult passing up some nice specimens, but the fact is most of us collect more material than we will ever use. We often let it pile up in our backyards until our heirs have to deal with it following our demise.

My friend and I discovered that we had to use a more discerning approach to our collecting. No longer were we merely bagging everything with the idea of doing our culling at home. Instead, we were culling in the field, and often doing so without actually removing the piece from its resting place. Not only did we have an easier time getting our material back to the truck, but we felt good for having chosen only what we knew we'd use.

At a different location, we found some beautiful pieces of agate, and removed just enough material for making a few gifts for our friends and family. Normally, we would have packed out as much material as our aching backs would allow. Upon arriving home, we would have tried to give most of it away. Too often we'd found that the folks back home already had more material than they would use in their lifetimes. So on this trip we removed just a few pounds of agate apiece. Again, we saved ourselves a great deal of work packing and unpacking rocks, and we left beautiful material undisturbed for the enjoyment of future collectors.

Perhaps catch-and-release mineral and fossil collecting could prove beneficial to all of us. Here are some ways to practice the technique, and why you might want to give it a try.

1. Take only the material you will actually use, and have a specific use in mind. If you plan to make jewelry, collect only what is necessary to make the piece. When planning to make a larger creation, perhaps just a couple of significantly larger pieces would be sufficient. Taking a little extra material, in case of lapidary errors, is understandable.

2. Take more photos and less material. I've started a scrapbook of fossil and mineral photos that I haughtily call "The Ones That Got Away." Although these nice specimens might have looked gorgeous in my front yard and given me great bragging rights, they looked better when left in their natural environments. This suggestion may seem almost as radical as the 1960s environmental slogan "Take only pictures, leave only footprints." It isn't. If I find myself really wanting a piece of the rock, I remove a small portion with my pick and leave the rest in situ.

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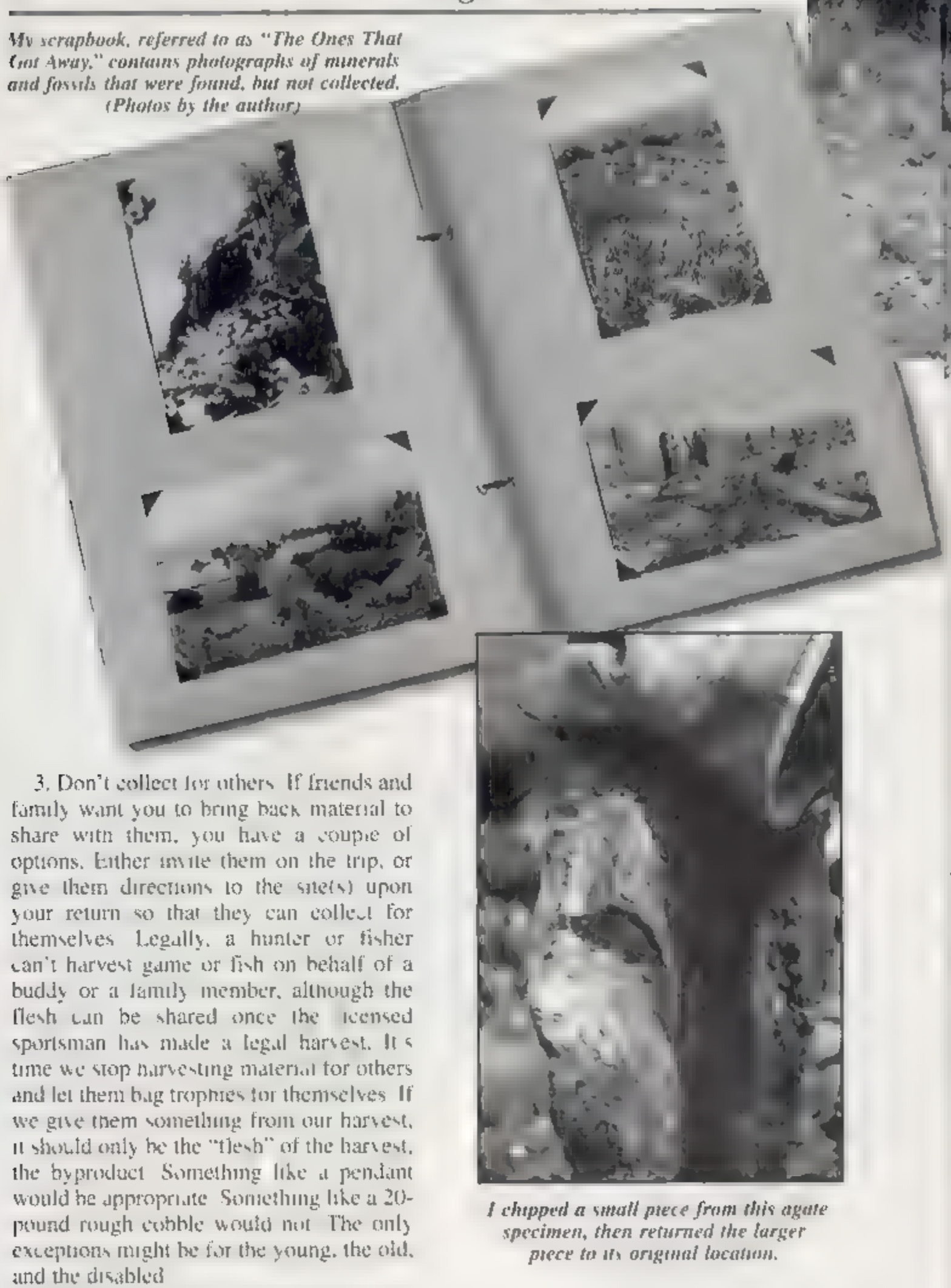
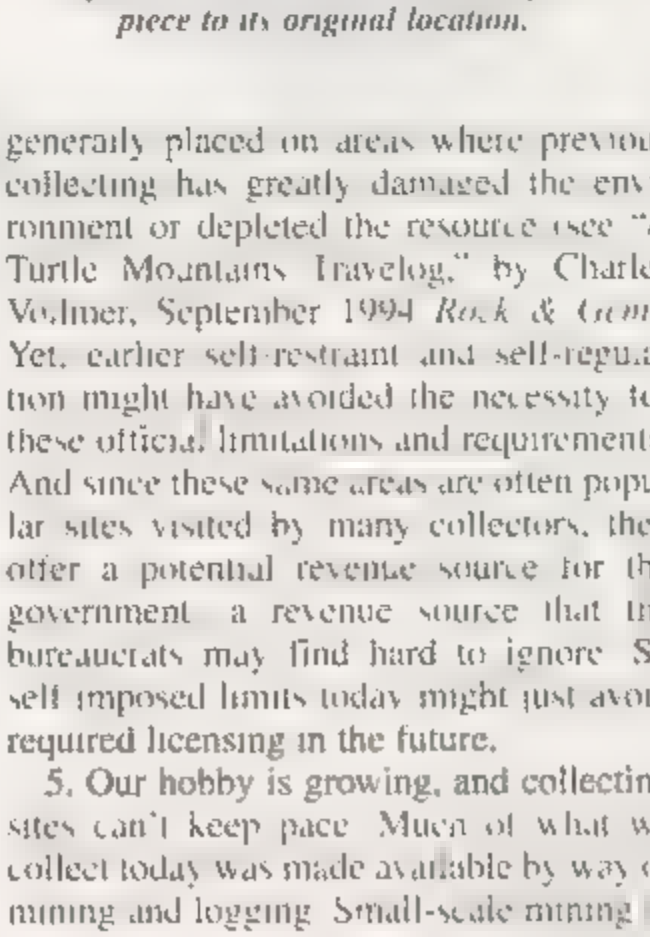
*My scrapbook, referred to as "The Ones That Got Away," contains photographs of minerals and fossils that were found, but not collected. (Photos by the author)*



3. Don't collect for others. If friends and family want you to bring back material to share with them, you have a couple of options. Either invite them on the trip, or give them directions to the site(s) upon your return so that they can collect for themselves. Legally, a hunter or fisher can't harvest game or fish on behalf of a buddy or a family member, although the flesh can be shared once the licensed sportsman has made a legal harvest. It's time we stop harvesting material for others and let them bag trophies for themselves. If we give them something from our harvest, it should only be the "flesh" of the harvest, the byproduct. Something like a pendant would be appropriate. Something like a 20-pound rough cobble would not. The only exceptions might be for the young, the old, and the disabled.

4. Embrace the concepts of self-restraint and self-regulation. By using self-imposed restraint and unofficial regulations (perhaps an amended version of the Rockhound's Code of Ethics) now, we may avoid the imposition of official regulations and requirements later (see "The Threat To Rockhounding," by Steve Voynick, September 1994 *Rock & Gem*). Some collectors of natural resources must buy state or federal licenses to pursue their hobbies. It wasn't always so for those hobbies, but the loss of resources, and the potential for revenue, led to the licensing requirements. Already, some areas within government lands have mandated quantity limits and collecting zones. And currently, a few fossil and mineral areas require that permits be obtained and carried when collecting. These restrictions and requirements are generally placed on areas where previous collecting has greatly damaged the environment or depleted the resource (see "A Turtle Mountains Travelog," by Charles Vollmer, September 1994 *Rock & Gem*). Yet, earlier self-restraint and self-regulation might have avoided the necessity for these official limitations and requirements. And since these same areas are often popular sites visited by many collectors, they offer a potential revenue source for the government — a revenue source that the bureaucrats may find hard to ignore. So self-imposed limits today might just avoid required licensing in the future.



*I chipped a small piece from this agate specimen, then returned the larger piece to its original location.*

5. Our hobby is growing, and collecting sites can't keep pace. Much of what we collect today was made available by way of mining and logging. Small-scale mining in particular made material available at tailings piles and mine dumps. The miners brought collectible material to the surface where it became easily obtainable. What was unwanted or unprofitable to the miners was often desirable to rock collectors. Other sites were made accessible through logging roads. Since the 1990s, both logging and mining, particularly on federal lands, have been greatly curtailed. The subsequent road closures have radically impacted our hobby. The easy access to and availability of collectible materials have been reduced in direct correlation to the constraints placed on those two industries. Fewer new collecting locations will be found and developed because fewer new mines and logging operations are being developed.

*On a recent fossil collecting trip, my partner and I collected only every third piece we found.*

The current administration in Washington D.C. may attempt to allow more mining and logging on federal lands (formerly known as public lands). Until that actually happens, however, we must use some self-restraint. By avoiding the hoarding mentality that many of us sometimes exhibit, myself included, we can prolong the life of some of the existing collection areas. This will give us time to find and develop new sites. And although many sources have yet to be discovered and developed, the rapidity with which they are made available will undeniably slow as a result of the changes affecting the development of federal lands. This is true even if the Bush administration opens more land for mining and logging, since it takes time to pass legislation and to start up operations. Collectors must acknowledge the limitations and growing unavailability of our resources. Until or unless new discoveries are again made frequently, we should find new ways to prolong the viability of current sites.

So whether fishing for trout or hunting for quartz crystals, practice catch-and-release after bagging your personal limit. With a touch of restraint and a little foresight, everyone can practice this resource-saving technique and still have plenty of trophies to bring home. Sometimes it's great when the big one gets away!

FIELD TRIP

# DESTINATION: SNOW LA

## Gold and Ordovician Fossils Draw Canadian Club Members

*by Kenneth H. Rohn*

When the Manitoba Mineral Society newsletter, *The Mineral Vein* arrived at my doorstep one day a few months ago, I saw something that instantly drew my undivided attention. The club members, through arrangements made by our field trip chairman, Jack Bauer, were invited to watch a gold pour at the New Britannia Gold Mine in the far north community of Snow Lake, Manitoba, population 1,310. This city is at the very end of the highway, 574 kilometers north of Winnipeg via provincial highways 6, 39 and 392. (One kilometers is approximately 0.6 miles.) What an extraordinary opportunity! I always wanted to see molten gold flowing out of a crucible, and this was a chance of a lifetime. I was excited!

I called Jack in Winnipeg and got the details. The New Britannia was scheduled to pour on a Thursday morning. Our group would drive up from Winnipeg to Snow Lake in a caravan the day before. The drive would take most of the day, including rest breaks and investigating possible collecting sites along the way. That meant that I'd have to leave home in Minnesota on Tuesday in order to meet the other participants in Winnipeg on Wednesday morning.

Reservations were made for me at the Blue Nose Bed & Breakfast, in Snow Lake, so I broke my tradition of taking the camper and packed my BMW sedan for the trip. The frosting on the cake for this trip would be a stop or two on the way, time permitting, to check out some very interesting collecting sites. I was about to embark on another great rockhounding adventure, one that was quite different from so many others I had participated in.

The first leg of the trip went well, my BMW diesel purred along, sipping fuel at a miserly rate of 40 miles per gallon.

*Members of the Manitoba Mineral Society collect Ordovician invertebrate fossils alongside Sturgeon Gill Road. Lake Winnipeg lies somewhere over the horizon. (Photos by the author.)*

*This boulder—and dozens like it—hold myriad clamshells from the Ordovician Period.*

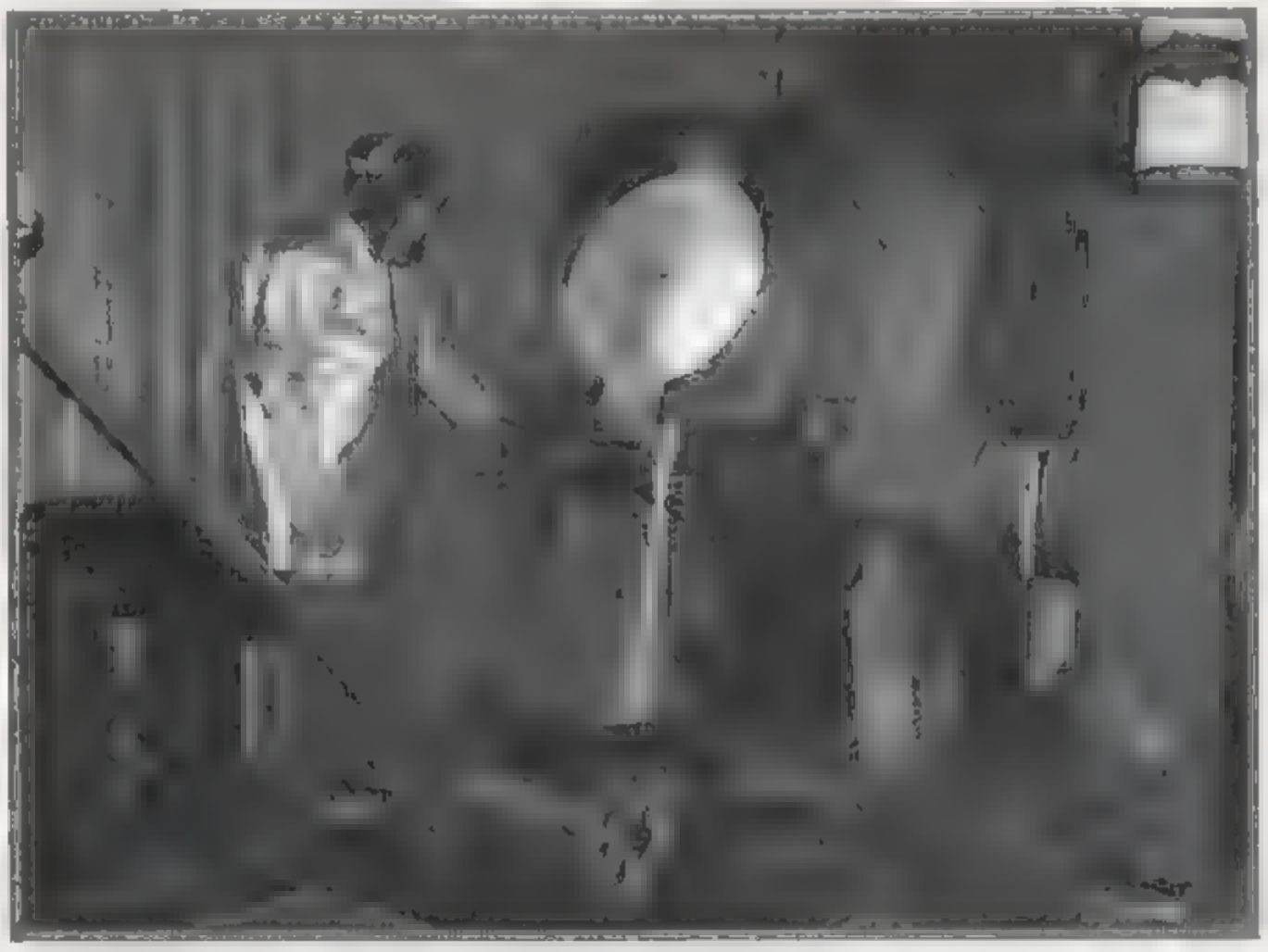
When I reached the northern extremes of Minnesota, I took state Route 11, The Lady Slipper Route, west to Warroad, crossed the border, and continued on provincial Highway 12 and Trans-Canada 1 to Winnipeg.

Wednesday morning, bright and early, we were heading north on provincial Highway 6. One member was pulling a fifth wheel trailer, so we gauged our speed by him. His pickup also burned diesel fuel, so when he stopped to fuel up, we all took advantage by having coffee and lunch breaks. My car has a very long range (better than 500 miles), so fuel was no problem for me. All the stations I stopped at sold diesel fuel. Some had the much larger commercial nozzles on their pumps, making it difficult to fill my tank at times. Countless huge freight haulers supply these far-flung communities on a daily basis.

*continued on next page*

FIELD TRIP

# DESTINATION: Snow Lake! *from page 53*



*Members of the Manitoba Mineral Society got to watch a gold pour at the New Britannia Gold Mine in Snow Lake Manitoba*

Between the tiny town of St Martin and Grand Rapids, Manitoba, (a distance of 140 kilometers) on provincial Highway 6, there is nothing but wilderness The same holds true for the drive between Grand Rapids and Ponton to the north (175 kilometers). There are no gas stations—no sign of civilization of any kind for that matter. For peace of mind along these lonely stretches, it's wise to fill the tank at every opportunity

Once on provincial Highway 6 after leaving Winnipeg, one sees some fields and meadows interspersed with underbrush and trees. Then, gradually, the forest takes over with rather stunted evergreens and deciduous trees. Here and there, cattle and dairy farms come into view. But after passing the intersection of Gypsumville, 236 kilometers north of the big city, you'll find only flat and wilderness until you hit Grand Rapids In many places, the trees grow so tightly together, it would be almost impossible to walk between them.

Provincial Highway 6 runs rather parallel to Lake Winnipeg in a north by northwesterly direction for 405 kilometers But I only saw the lake once north of Grand Rapids, despite the fact that this huge body of water is very close to the highway in two places.

Thirty-two kilometers north of Grand Rapids on provincial Highway 6 is Sturgeon Gill Road, to my knowledge, only the second road to be found on the route north of Grand Rapids It leads off to the right (east) This was our first collecting stop We would search for Ordovician invertebrates here This rather narrow road has a gravel surface and was solid enough for the heavy fifth wheel camper, although I noticed when the driver turned around that the shoulders were a bit soft

The collecting site is approximately five miles in on Sturgeon Gill Road I believe this road goes all the way to Lake Winnipeg further investigation might prove that, but from where our party stopped, we could not see the lake. There may be other sites closer to the highway, because the lay of the land looks favorable for fossils. However, our group did not check them out due to our tight schedule

We stopped on a hilltop overlooking the vast forest to the east. There was no sign of the lake, but I suspect that it lay just beyond the next horizon. Ordovician fossils such as shellfish and coral were everywhere in the road cuts and along the higher slopes on the right side of the road and in the gravel pit on the left side looking east. The majority were not all that well defined and appeared to have been altered due to metamorphism caused by high heat and extreme pressure those millions of years ago

According to the major stratigraphic time divisions conducted by the U S Geological Survey, the Ordovician Period was in the Paleozoic Era, some 430 million to 350 million years ago This includes the Devonian (the youngest at 315 million to 255 million years ago), the Silurian (350 million to 315 million years ago), Ordovician, and Cambrian (510 million to 430 million years ago) respectively.

As I walked slowly along the road cut, I saw proof positive that myriad sea creatures lived here and died quite possibly instantaneously after a major volcanic eruption and heavy ash fall in or near this vicinity when the Earth was young. I suspect that some of them may have come from a later period, namely the Silurian, such as the very distinct, tiny crinoid stem section that I added to my collection It protrudes from a beautiful pink slab the size of a saucer, 1 inch thick. It was found in the cut on the right side of the road The crinoid was a member of the Crinoidea species, a lily-like sea creature that thrived during the Silurian period

The high embankment on the south side of the road proved most interesting I saw huge slabs of gray to pink dolomitic limestone whose surfaces were covered with shellfish. There were literally hundreds of them in many of those huge slabs, positioned very close together in death as they were on the shallow sea bottom in life, so long ago. Brachiopods were numerous, and although I found it difficult to identify many of them, some appear to be Middle to Upper Ordovician Lepidocyclus They are commonly less than a half inch to a bit larger than an inch with a rather rounded shape. I would venture to say that the brachiopods Meristina were in this time zone as well, with a length of an inch and a well-rounded, convex shell The ribs on some of the shellfish I collected have a well-defined, distinct pattern, despite the alterations mentioned above.

The matrix that imprisons these fossils is extremely hard and many members of our group found it a tedious task to extricate them with rock hammers and come away with an intact specimen As a rule, I collect without my geology hammer I managed to discover some nice, small pieces of matrix with well defined shellfish in them and even an easily recognized, well-preserved horn coral 3 inches long and 1 inch in diameter

Coral appears to have been quite plentiful here I found the majority of my specimens on the left side of the road in the gravel pit, and it was easy to pick up many manageable-sized specimens for my rock cabinet in that area These ancient anthozoans lived in large colonies, often to the extent of eventually forming islands in that ancient sea. Today, similar species resembling those early sea inhabitants still live in warm, shallow seas not much deeper than 100 feet The predom

*continued on page 56*

# DESTINATION: Snow Lake! *from page 54*

nant species at this collecting site appears to be colony coral, with a horn coral here and there. I also discovered pieces of matrix with petrified algae so well defined that they appear lifelike. Some of the limestone has been partially altered to marble with a pleasing pink hue, but some of the visible fossil forms were partially obliterated when the stone was subjected to extreme heat and pressure.

After a brief stop to collect a few specimens, it was time to leave. We wanted to arrive in Snow Lake by late afternoon.

Snow Lake is a typical northern mining town. The hoist tower of the New Britannia Mine looms up above the horizon and is quite pronounced as one enters the community. One can find just about anything here that is available in any more southerly city, though I failed to find a camera shop when my camera decided to malfunction one day.

Thursday morning found our group gathered at the mine. It was a soggy day, having rained the night before, with heavy overcast and a fine rain still falling. There were two gold pours that morning. Approximately half our group chose to take the underground tour, they simply couldn't accommodate all of us together. My group would watch the first pour, and the other group would watch the second pour after their tour.

After signing in, we were given hard hats (I wore my own) and a short talk about the history of the mine. We were told that it takes two hours for the kiln to heat up to the proper temperature. It was almost ready. Soon we were led into a small room in the large beneficiation mill building. Someone closed the wire mesh gate behind us. Superintendent Shaan Healy, in charge of the pour, briefly explained the procedure and answered questions while we waited. Some of us were permitted to lift one of the pails of concentrate. The 5 gallon container was extremely heavy, although it was only three-quarters full. The first thing that caught my attention was the computerized control panel on the far wall, and right in the middle of the floor rested the kiln. It was already white hot and I actually had to squint when I looked at the brilliant, blazing hot crucible. It was almost like looking into the sun.

Many of us were wearing jackets that morning. It was cold outside, despite the fact that it was August, but uncomfortably warm inside that small room. We stood not more than 15 feet from that blazing inferno while the men made ready for the pour. The first thing they did was to don protective clothing. Next, a large wok-shaped container was placed in front of the crucible. The slag was poured into that. I marveled at the skill of the man who poured. I wondered just how he knew when the slag left off and the actual gold might spill into that bowl, but then I realized that this was not a one-time thing. They are experienced and pour every two weeks. Everything is recycled; nothing is lost. The floor is vacuumed clean, the worktables are scoured, and even the slag glass is returned to the kiln along with the filters to be burned and melted over again so that none of the precious gold is lost.

After the slag was removed from the crucible in a white-hot stream, a step-shaped device containing three heavy molds, one below the other, was placed under the pour spout. Then the molten gold was slowly poured out in a thin stream at around 2,000 degrees F. It reminded me of a molten waterfall, with tiny sparks flying about, running from the first mold down to the second and then the third. They had it timed perfectly, with none of the gold spilling over out of the third mold by the time the pour was finished. It had a reddish, buttery glow while in the molds. After a few minutes, the molds were slammed down hard on the iron floor and the ingots removed. Slag glass had quickly solidified around the edges of the ingots and was pounded off with a hammer. Then, still dangerously red hot, the ingots, about the size of a stubby loaf of bread, were carried over to a water tank and dropped in. They were hosed down amidst a cloud of steam until cool enough to handle with bare hands. Each one was cleaned on a heavy iron table with a pneumatic wire brush. This is when the beautiful, distinctive gold color came out. Those bars glistened under the lights like the purest golden honey. We were allowed to hold one of the huge bars. The one I held weighed 75 pounds and was worth a cool $245,000.

Someone asked about the possibility of theft. We were told that no matter where these bars went, they could always be identified as coming from the New Britannia simply due to their unique composition, and also by a special method of identification.

After a previous history of mining at this site by other companies, the new owners began production in July 1995 after an extensive renovation program. The first bullion was poured in November 1995. As of March 2002, the New Britannia had mined better than 620,000 ounces of that precious yellow metal, a most impressive figure considering the fact that the gold particles are invisible to the naked eye in the host rock. The mill is in operation 24 hours a day, seven days per week, with an output of 2,500 tons per day of gold bearing rock.

*Invertebrate fossils like this are plentiful at the Sturgeon Gill site. This appears to be a horn coral*

The company uses conventional crushing and grinding methods (large rod and-ball mills for the final reduction) followed by cyanide leaching and Carbon Pulp technology. They tell me the gold is recovered by pressure stripping and electrowinning. From there it goes into the smelter in an induction furnace, along with other ingredients, to produce gold with up to 90 percent purity. That's 22 karats!

The mine operators have taken great pains to protect the environment by monitoring air and water quality and complying strictly with Provincial regulations by reclaiming and revegetating tailings areas. The water is recycled and used over and over again.

My stay at Snow Lake entailed four days. Some of the members stayed longer, but I had to return. Duties called. During my stay, our group was escorted to various collecting sites around the area. One interesting place is the abandoned marble quarry approximately 15 miles south of Snow Lake off provincial Highway 392. It's well worth investigating. Here, on both sides of the road, lies a huge excavated area with piles of crushed rock and countless gigantic slabs scattered about. This pink marble has good potential for invertebrate fossils, but again, the host rock is extremely hard. I discovered several good specimens of colony coral in the quarry on the right side of the highway facing south. If one should spend more time here, I'm sure many interesting specimens would come to light. Always wear eye protection when pounding on rocks.)

In a waste rock pile right on the edge of town, our group found many good specimens of iron pyrite and small pyrope garnets, many of gem quality, but tiny. Most were still in their matrix and will make nice cabinet specimens.

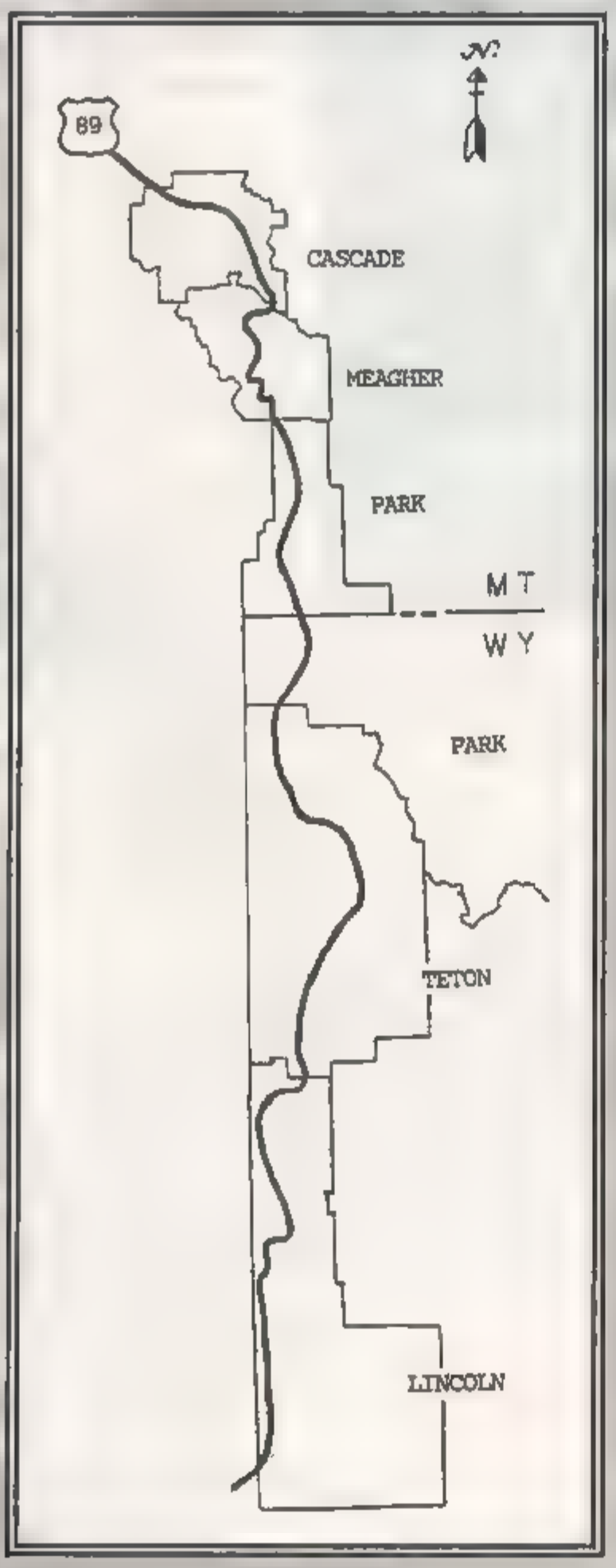
I left on Sunday for home and said good bye to many old friends and a few new ones. My stay at the Blue Nose Bed & Breakfast was comfortable, and despite the fact that it rained off and on every day that I was there, I had a most exciting time.

If you feel the urge for adventure and want to see a gold pour in the far north, that rare opportunity might be available. Contact Bill Lewis (Underground and Mill) or Shaun Healy (in charge of gold smelting) c/o New Britannia Mine, PO Box 451, Snow Lake, MB R0B 1M0, or call (204) 358 2927. It's more or less compulsory that you write well in advance so that possible arrangements can be made for you to visit the mine. Also, it's a matter of courtesy to send a self-addressed envelope, along with an international reply coupon to cover return postage. U.S. postage is not acceptable for return mail from Canada.

If arrangements can be made enabling you to witness the unique experience of watching molten gold being poured, you'll not soon forget it. I know, I won't.

GOLD AND GEM HIGHWAYS

# PANNING SITES ALONG U.S. HIGHWAY 89




## Tracing the Potential for Mineral Finds in Wyoming and Montana

*by David and Clois Walker*

Already too old for pannin' gold? Not if you don't have to climb over hill and dale to get to the particular streams you've decided on! Why not try your luck beneath one or two of those nice, shady highway bridges instead, particularly in areas where appreciable finds have already been made upstream from the intersection?

To gain a little insight on this concept of gem and mineral prospecting, one has only to take note of how the sediments of a stream have been rearranged between visits, particularly the gravel bars, which are shifted about with virtually every rainstorm.

For quite some time now, we've been researching highway stream intersections along a number of the more prevalent vacation routes in 13 western and four southeastern states, including that portion of U.S. Highway 89 that extends in a northerly direction from Alpine Junction, Wyoming, to Monark, Montana.

First, we plotted the locations of mineral deposits previously reported by the U.S. Geological Survey and others on topographical or shaded relief maps. From there, we traced anticipated float along existing rivers and streams to the nearest highway/stream intersections. The more advantageous situations, from both access and findings perspectives, became increasingly apparent—apparent enough, that is, to allow us to compile the categorical listing that follows. We delineated the details of these locations on hand-drawn vicinity maps on an appropriate scale with corresponding areas on the official state highway maps.

Again, the convenience of being able to access panning sites from highway rights of way can scarcely be overemphasized, since it eliminates the necessity of locating, then negotiating terms and conditions with, private land owners. Nevertheless, the usual safety and environmental regulations should be observed

New or renewed discoveries are being made year after year, on the same old streams, simply by adhering to the same old field guides. So what's the matter with a little daydreaming now and then?

## LOCATION AND VICINITY FINDS ALONG U.S. HIGHWAY 89

WYOMING
Lincoln County (Maps WY1-2)
Site 1 Crossing on Grey s River, near ALPINE JUNCTION Vicinity finds indicate gold potential.

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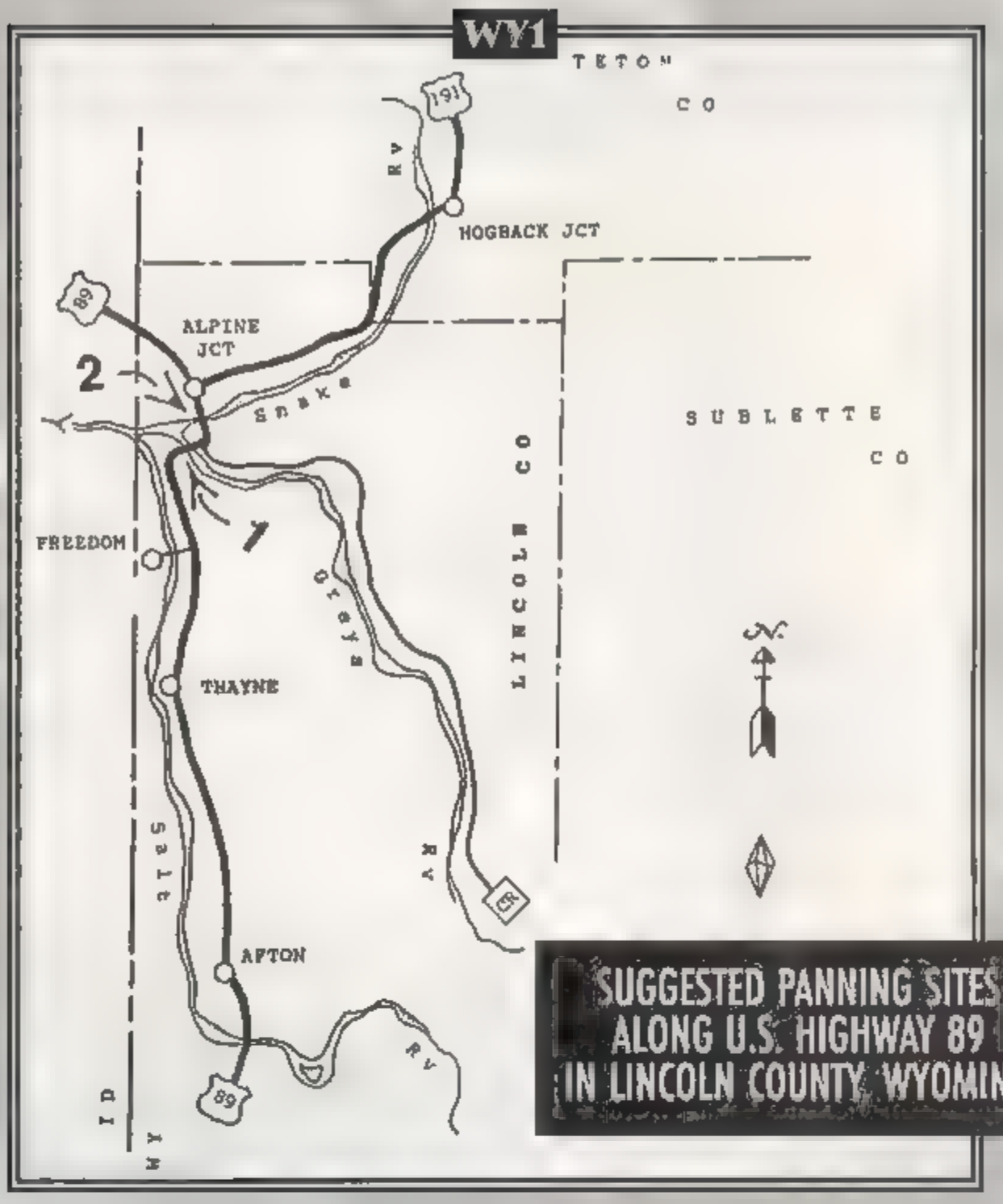
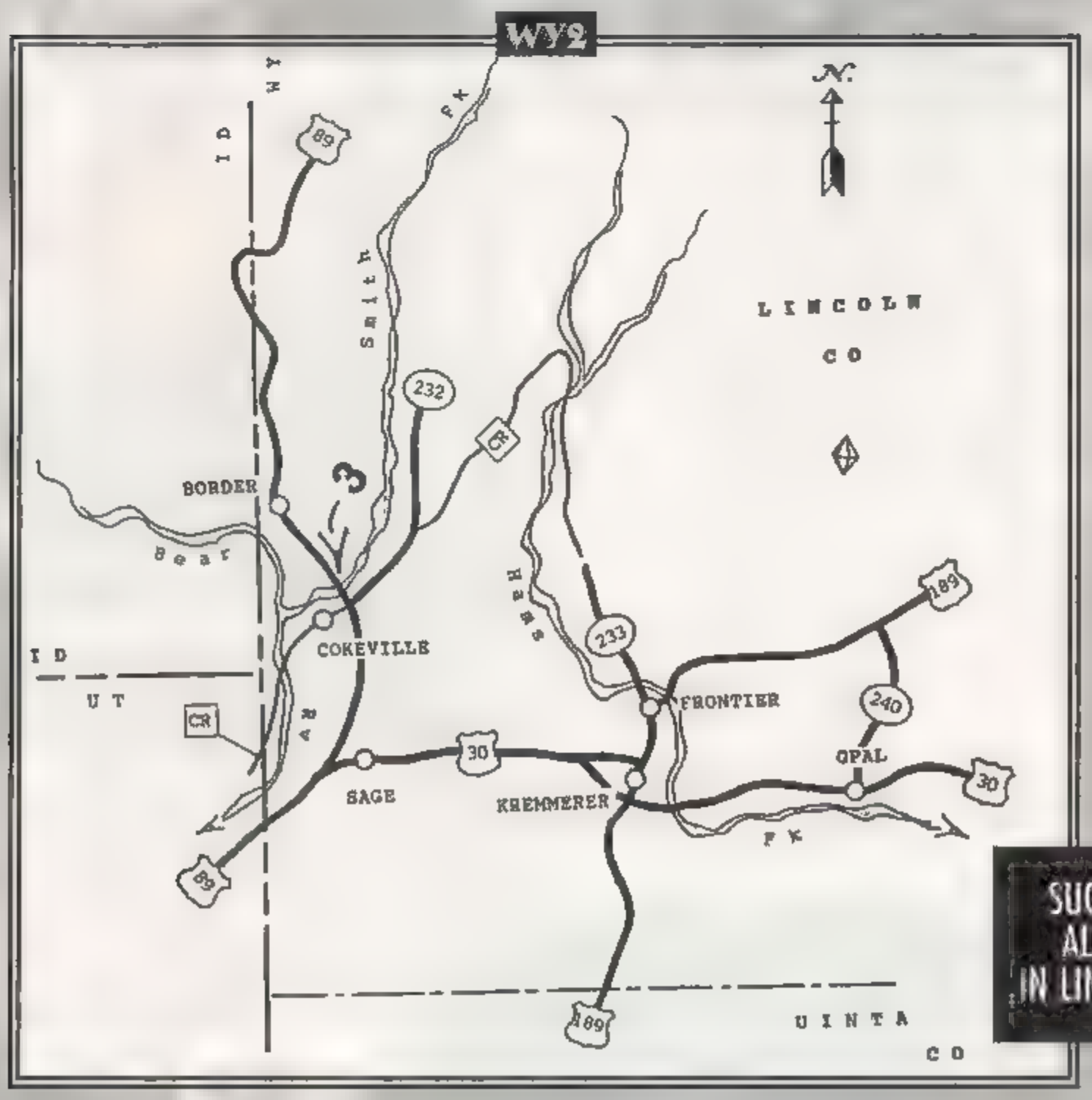
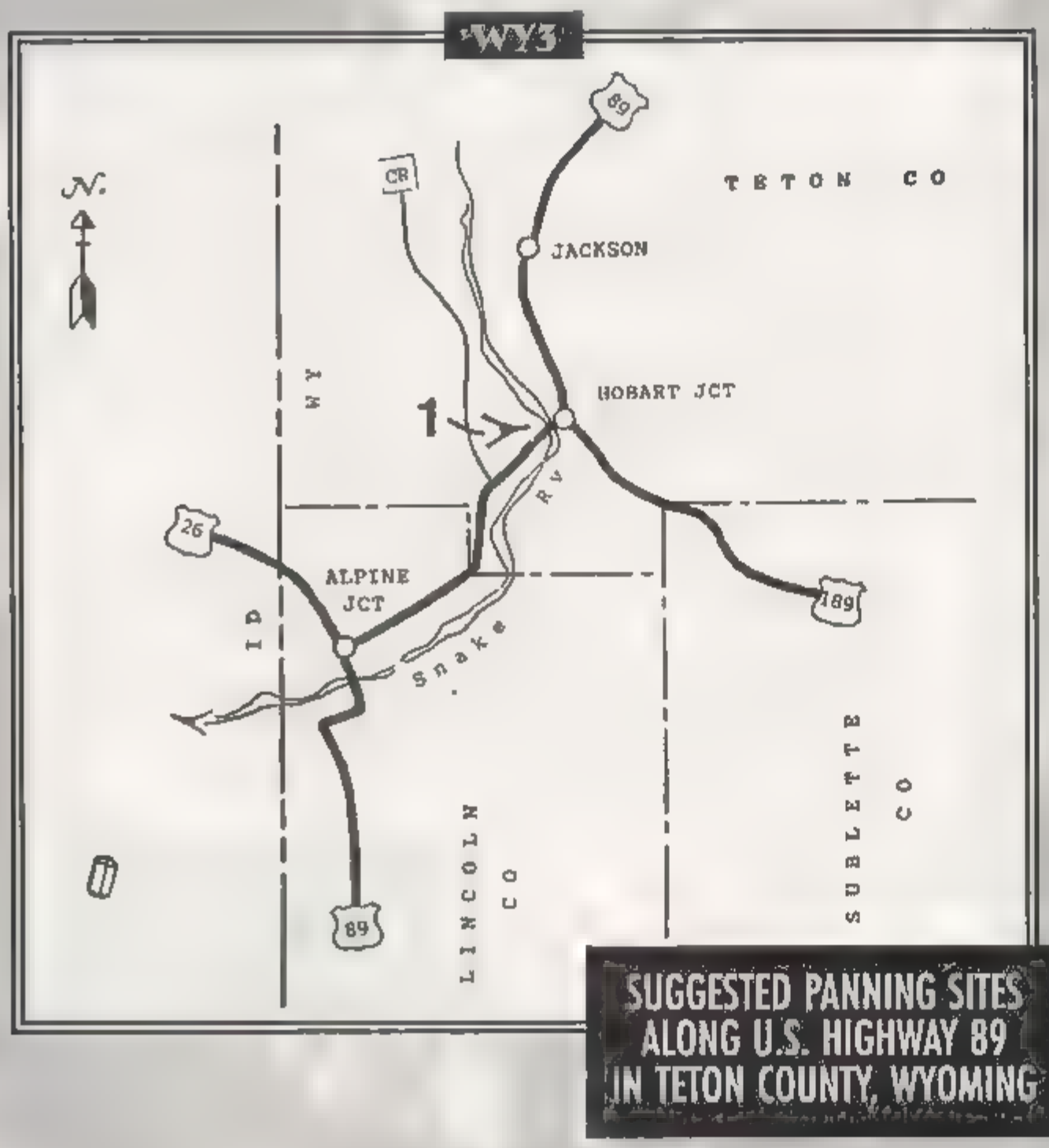


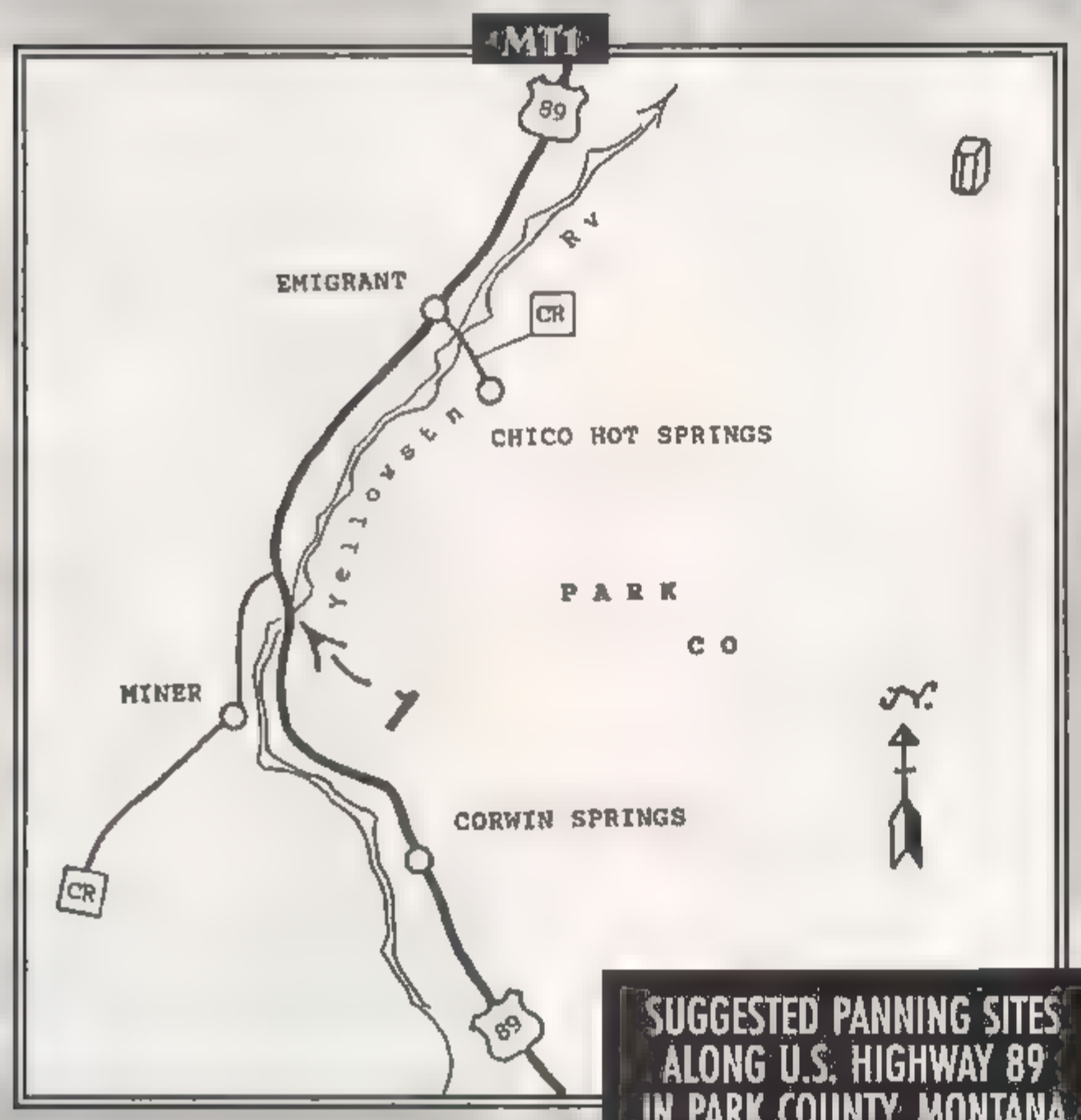






SUGGESTED PANNING SITES ALONG U.S. HIGHWAY 89 IN TETON COUNTY, WYOMING

Site 2 Crossing on Snake River, near ALPINE JUNCTION Vicinity finds indicate gold potential
Site 3 Crossing on Smith Fork of Bear River, near COKEVILLE Vicinity finds include agate, chalcedony, jasper, opalized wood, quartz, and silicified wood.

Teton County (Map WY3)
Site 1 Crossing on Snake River, near HOBART JUNCTION Vicinity finds include agate, gold, jasper, quartz, and silicified wood

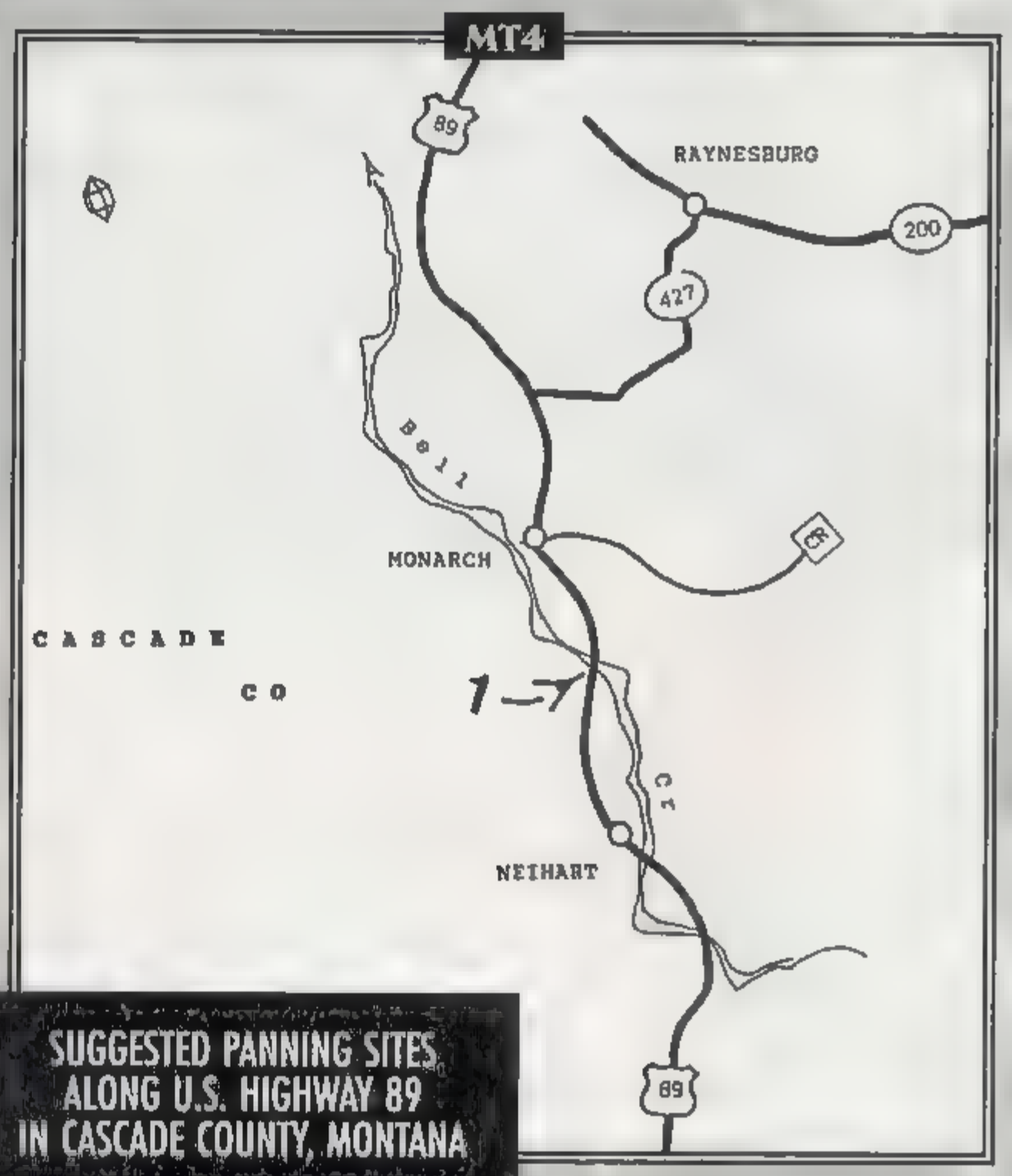



SUGGESTED PANNING SITES ALONG U.S. HIGHWAY 89 IN PARK COUNTY, MONTANA

MONTANA
Park County (Maps MT1-2)
Site 1. Crossing on Yellowstone River, near EMIGRANT. Vicinity finds include agate, gold and jasper
Site 2 Crossing on Yellowstone River, near LIVINGSTON Vicinity finds include agate, gold, opalized wood, quartz, sapphire, and silicified wood

Meagher County (Map MT3)
Site 1 Crossing on Smith River, near WHITE SULPHUR SPRINGS Vicinity finds indicate gold potential
Site 2 Crossing on tributary of Smith River, near RINGLING Vicinity finds indicate gold potential

SUGGESTED PANNING SITES ALONG U.S. HIGHWAY 89 IN MEAGHER COUUNTY, MONTANA




SUGGESTED PANNING SITES ALONG U.S. HIGHWAY 89 IN CASCADE COUNTY, MONTANA

Cascade County (Map MT4)
Site 1 Crossing on Bell Creek, near MONARCH Vicinity finds include agate, chalcedony and gold

The official state highway maps are suggested in conjunction with the vicinity maps for overall orientation in the field.

PARK

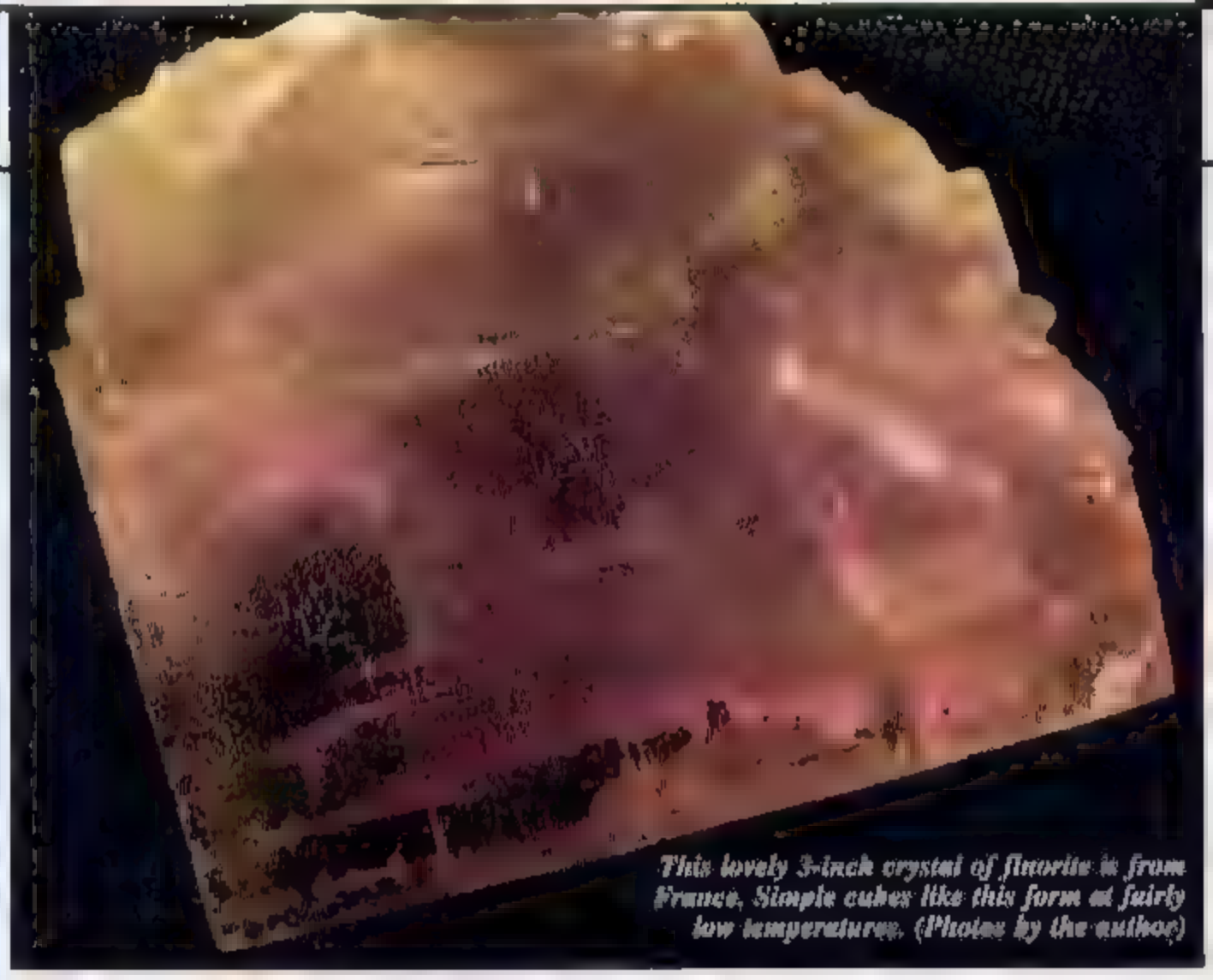
CO

T-2

NE CREEK

SUGGESTED PANNING SITES ALONG U.S. HIGHWAY 89 IN PARK COUNTY MONTANA

# MINERAL HARDNESS ACCORDING TO MR. MOHS



*This lovely 3-inch crystal of fluorite is from France. Simple cubes like this form at fairly low temperatures. (Photos by the author)*

*Evan Jones stands before a huge pocket of crystallized gypsum (selenite), hardness 2 on the Mohs scale*

## Part I: Gypsum through Fluorite

*by Bob Jones*

One of the physical properties we often refer to when writing about a mineral is its hardness. It is usually expressed in terms of a number from one to 10, thanks to Friedrich Mohs, a scientist who lived in the 1800s. But when using hardness, keep in mind two things: Hardness is a relative thing on Mohs' scale, and even within a given specimen, the hardness can often vary. Take calcite, for example. Scratched one way, it can have a Mohs hardness of 3. Scratched in another way, it can be a little harder, maybe 3.5, another way, and it is slightly softer!

Just where Mohs was born seems to be something of a puzzle. In some references, he is mentioned as having been born in Austria in 1773, but in other literature he is credited to Germany and also France.

Be that as it may, Mohs is from the Gernrode/Harz region of Austria. He studied at the Halle Saale University, majoring in math, physics and chemistry. During these and later studies, he was struck by the varying degrees of hardness of different minerals. Later studies took him to the mining academy at Freiberg, and he became Professor of Mineralogy at Joanneum in Graz by 1812. He had studied under Abraham Gottlob Werner, who is very famous for his contributions to geology.

Friedrich's first employment was as a pit foreman at the Neudorf/Harz Mine in 1801. That doesn't sound like much, but the region was fraught with fine minerals, to which Mohs devoted his time. In 1826, he became Professor of Mineralogy at the University of Vienna. He died at the age of 65 in 1839.

His relative scale of hardness was developed during his work at Freiberg, and in 1812 he released his now-familiar hardness scale. That scale has several caveats attached, some of which I have already mentioned. First, Mohs had to choose representative minerals that are fairly common, otherwise the scarcity of test minerals would defeat the purpose of the testing. The test minerals would also have to be of a more or less predictable hardness. For example, he could not choose something like kyanite, because when scratched along the long axis, the hardness of kyanite is about 4.5, but when scratched across the crystal face, its hardness is 6.5. Still, he did choose calcite, which also has a bit of variance in its physical hardness. But the difference only ranges from just under 3 to just over 3 on the scale, so it falls within a range of tolerance.

In 1822, 10 years after he had been made Professor of Mineralogy at Joanneum in Graz, Mohs released his standard scale. The minerals and their relative

*Fluorite can come in a variety of crystal forms, but its hardness (4 on the Mohs scale) was consistent enough for Friedrich Mohs.*

*Calcite (Mohs 3), while forming lovely crystals, also comes in weird shapes.*

hardness are talc (1), gypsum (2), calcite (3), fluorite (4), apatite (5), orthoclase (6), quartz (7), topaz (8), corundum (9), and diamond (10). It is very important that you understand the differences between these numbers. Gypsum is not twice as hard as talc, any more than diamond is 10 times harder than talc. The scale is one of relative numbers—relative hardnesses.

One way to test minerals in the field is to carry a small kit holding nine specimens (all of the above except diamond). More often, certain common items can be used as a substitute to something more formal. One item is your fingernail, which will scratch anything at 2 or less. The point of a knife blade will easily scratch anything with a hardness at or below 5. It will barely scratch minerals of a hardness 6. Quartz, with a hardness of 7, and everything harder will scratch glass.

*continued on next page*

# Mineral Hardness According to Mr. Mohs *from page 65*

Scientists find the Mohs scale a bit unreliable so they use other methods to test a mineral's hardness including an instrument called a sclerometer (also spelled skerometer). The prefix sclero comes from the French word for hard. There are other, much more accurate scales of hardness. The Knoop scale, for example, uses numbers from zero to 8,000, which are established using a diamond point to penetrate a mineral surface.

In any hardness check, what is actually being tested is the molecular cohesion within the structure of the specimen. This cohesion depends on the force of attraction between the individual molecules of the test mineral, a force that causes the molecules to hang onto each other with greater or less tenacity. So, when testing hardness, you are dealing with this force of attraction, or lack of it. Some molecules, as in the case of some oxide minerals, can bond very tightly, therefore a lot of pressure is required to create a scratch line. Others, as in the native elements, have a much weaker force of attraction or cohesion, so the mineral crumbles more readily.

One of the problems with testing a subject mineral is when the test specimen has a granular structure, a structure that can be macroscopic, like marble, for example. When you scratch a piece of marble, a powdery scratch line may fool you into thinking the mineral is soft. But in the case of marble, which can have a very fine granular structure, what really happens is that tiny, more or less rounded bits of the stone roll out to create the impression of a powder resulting from a scratch. Couple that with an acid test, to which both respond, and unless you are very careful you can identify a bit of marble as a fragment of calcite.

If we take a closer look at Mohs' list of 10, we can see the wisdom of using the test while also pointing out some of the pitfalls. We've already mentioned that different faces of the same crystal can have slightly different hardnesses. Even the direction in which you scratch the face of a specimen can make a difference, again by slight differences in the cohesion based on the internal molecular structure. So, while the Mohs hardness scale certainly has a use in identifying a mineral, it is always wise to use other tests in conjunction with the scratch test to reach a tentative conclusion.

While the hardness of minerals depends on the cohesion within the molecular structure, this, in turn, is related to the chemistry of the mineral. I've already indicated that the native elements are not particularly hard when compared to mineral compounds. Measuring about 2.5 to 3 on the Mohs scale are such familiars as gold, silver and copper. Lead and sulfur are considerably softer at 1.5, while platinum and iron run as hard as 4 to 4.5. Other metals like arsenic, antimony and amalgam test at about 3 to 3.5. Of course, the exception everyone knows about is diamond, which is more or less pure carbon with an unusual molecular structure. It is the hardest naturally occurring mineral, measuring 10 on the Mohs scale. On the Knoop scale, diamond's hardness rating far exceeds the one number jump between corundum and diamond on the Mohs scale. On the Knoop scale corundum has a factor of 2,000, while diamond comes in at 8,000. Incidentally, graphite, which is also pure carbon, has a hardness of only about 1.5. Graphite's molecular structure has such a dramatic plane of weakness that it glides and separates under the slightest pressure. Pencil lead, for example, is graphite, but it has to be mixed with clay, as it is too soft in pure form. Imagine your schooling if there were no easy gliding graphite pencils or erasers that can remove graphite's streak!

As in calcite and so many other minerals, the crystal face tested can vary in hardness within itself depending on the direction of the scratch test. Hardness can also vary among prism faces on the same crystal.

When a faceter decides to work with a diamond, he has to know the crystal form of the stone since it is easier, relatively speaking, to grind the cube face of a crystal than the octahedral face. Of course, nature whimsically forms most diamonds as octahedrons, not cubes, just to test a faceter's resolve!

Starting at the bottom of the Mohs scale, talc is a relatively common mineral, which has several physical forms ranging from foliated, or leaflike, to densely compacted. It is a secondary product of metamorphic action, so it is found associated with other metamorphic minerals like chrysotile asbestos and serpentine. In any deposit that produces these important industrial and carving minerals, you can expect to find some talc, which can also be carved nicely. In fact, beginning carvers often practice on the rock steatite, the most solid form of talc, as it is inexpensive and easy to work. Well known deposits are in New England, New York, North Carolina, Pennsylvania, and several places in Europe. It is an industrial mineral, used as a paper filler, as a dry lubricant, as a carving stone, and even in bath or toilet powder. The white, powdery stuff we sprinkle on our bodies is really talcum powder.

with a pleasant perfume added!

Of all the minerals on the Mohs scale, gypsum certainly ranks close to calcite both as an industrial and a collector mineral. Certainly, gypsum has been found in free-standing crystals larger than those of any other species. Yes, there are huge quartzes, but I doubt any have been found that are 50 feet long and free standing. Spodumene has been reported in 50-foot and even longer crystals, but not free standing, being embedded in a South Dakota pegmatite quarry wall. Gypsum, in its crystal form selenite, has been found in crystals to 50 feet long, as I have written about in *Rock & Gem*.

As an industrial mineral, gypsum certainly is important, since the interior walls of most homes are constructed either of wallboard (crushed gypsum sandwiched between two heavy brown paper sheets) or as wall plaster (gypsum that has been partially heated to drive off some of its water, then mixed with water and allowed to harden as a stark, white wall). Doctors use gypsum when they mend a broken limb by encasing it in plaster of Paris. This, too, is made of what is sometimes called "burnt" gypsum, processed much like wall plaster. Gypsum is even ground up and scattered as a soil conditioner.

Gypsum is hugely common as a sedimentary deposit. It is also found abundantly in many hydrothermal deposits as discrete crystals, usually water clear and showing marvelous crystal variations, ranging from slender prisms to curving ram's horn groups. In addition, it can be found as a fine, granular rocklike material we call alabaster, which has been used as an artistic carving medium for millennia.

It's no wonder Mohs chose gypsum for his hardness 2 species. It is utterly common and abundant. Yet, it, too, varies slightly in hardness from about 1.5 to 2, again depending on the crystal form and how it is scratched.

The word gypsum comes from the Greek gypsos, which means chalk, the condition achieved when gypsum's water is driven off. Its chemical composition is hydrous calcite sulfate, with water attached to calcium, sulfur and oxygen. The name plaster of Paris refers to the huge deposits that were worked at Montmartre, outside Paris, France. Massive alabaster deposits were common in Egypt, and it was used for making vases, jars, vessels, and the like. English alabaster, found in Nottinghamshire, has a decided pink hue and was used in the decor of many manor houses.

One of the very popular collector deposits through many decades has been the great Salt Plains of Oklahoma, where the selenite, as the crystal form is called, can be found in radiating clusters always colored brown by included sand. The prettiest of these are those totten singles, crystals showing a lovely hourglass image due to the included sand.

For the serious collector, selenite can be found in a number of hydrothermal deposits, particularly those in Mexico. Mines at Naica and Santa Eulalia, both in Chihuahua, have been very prolific producers of selenite gypsum. Though crystals reaching 10 feet have been found in Chile, the champion crystals come from these two deposits in Mexico. I personally measured a fallen selenite in the Caverna de Santa Barbara that reached 23 feet in length. Even that is dwarfed by the 50-footers we saw in the deep cave at Naica.

Perhaps the most appealing selenites are the perfect, water-clear, monoclinic crystals that can reach a foot across. These are rivaled by superb, curving ram's horn clusters that can be several inches thick and over a foot in length.

In Europe, there are two deposits that have been particularly prolific in recent decades. From Spain come textbook perfect, water-clear blades jutting from cavities in a sedimentary rock. From several deposits in Sicily, at Girgenti and Racalmuto, choice, water clear, single crystals are associated with, and sometimes enclose, bright-yellow sulfur crystals. These very showy specimens are formed in association with volcanoes, a yet different occurrence.

Volcanoes have been prolific producers of sulfur, which emanates as hot vapors and sublimates on the walls of the crater, which means the sulfur passes directly from a gas to a solid, skipping the liquid phase. When the Spaniards conquered Mexico, they enslaved the locals and forced them to climb into still-active volcanic craters and scrape sulfur from the walls for use in gunpowder. Since sulfur fumes and other such gasses like hydrogen sulfide are poisonous, such slaves lived a short and painful life.

Calcite, with a hardness around 3, was another easy selection for Mohs to make. It is one of the most universally occurring minerals and is often found in fine crystal form. In fact, calcite has been identified as having well over 300 different crystal forms. It is also found in vast, massive deposits of rock we call limestone. That, in turn, gets metamorphosed by heat and/or pressure to create marble.

The immense industrial uses of limestone and marble are unrivaled. Very fine-grained limestone had great application in

*continued on next page*

# Mineral Hardness According to Mr. Mohs *from page 67*

the earlier days of printing, as it was used to produce lithographic prints. Cement is made from limestone, and cement, in turn, is mixed with sand and gravel to give us concrete. Where would we be without such a building material? And limestone and marble are universally used as building blocks. The huge pyramids of Egypt are just one early example of the use of limestone, which is impure calcite in rock form. All of our important national buildings in Washington, D.C., and most state capitols are made of either limestone or marble. And in the Midwest, where limestone abounds, a majority of homes seem to be constructed with limestone.

If you have ever visited Yellowstone National Park you have doubtless thrilled at the sight of Minerva's Terraces, a series of snow-white to colorful, rounded terraces over which hot, mineral-rich solutions flow, building layer upon layer of calcite in the form of travertine.

Travertine, to which the term onyx is usually coupled, is a wonderfully inexpensive carving and lapidary material. It is the stuff that hot springs build as they surge to the Earth's surface, having dissolved calcite limestone on its way. In caves, the lovely, striped, curtainlike "bacon" formations are a form of travertine. Huge deposits in Mexico have long been mined and used for everything from chess sets to vases. The term onyx is also applied to a form of quartz. When the single term onyx is used it denotes quartz. When describing the calcium carbonate form, then two words—travertine onyx—help define the difference.

Calcite has scientific uses, as well. Most important is its ability to polarize light in testing instruments. And during World War II optical calcite was a critical component of bombsights.

For the specimen collector, calcite offers the greatest variety of crystal forms of any species. Most treasured are probably those crystals that are very colorful, like very lovely cobaltian calcite, or rusty red hematite-included calcite. In the Southwest, collectors swoon over those calcites rich with colorful inclusions like green fibrous malachite or fiery red fibrous chalcotrichite. Equally sought by collectors are the geometrically amazing twinned calcites. Some of the finest such have come from the long defunct mines of England.

Number 4 on the Mohs scale is fluorite, another abundant mineral. One of fluorite's lovely physical properties is its variety of colors. It should be colorless, but can range through almost the entire color spectrum. Some colors are quite

rich, while others are very delicate. And within a given crystal, there can be a very attractive linear zoning of colors that follows the cleavages or crystal forms. Fluorite's colors are due to several causes. When it forms in limestone, which may hold some hydrocarbons, this impurity can cause color and color zoning. The yellow-brown fluorites from Clay Center, Ohio, are an excellent example. A lot of fluorite gets its color from what are called color centers, missing electrons in the structure that affect light to cause quite lovely colors. Fluorite that forms in hydrothermal deposits may fit this condition. A third cause of color in fluorite, and the one that gives much fluorite its superb fluorescent response, is the presence of rare earth elements in the structure. The world famous fluorites from the lead mines in England have been shown to be rich in rare earth impurities. In addition to being fluorescent (this phenomenon is so named as it is best seen in fluorite), the mineral can also be thermoluminescent (glows when heated), and is even triboluminescent (gives off flashes of light when two pieces are vigorously rubbed together).

Fluorite can express a number of crystal forms ranging from cubes with six perfect sides to as many as 48 faces in a very complex crystal. The crystal forms seem to be directly related to the conditions under which they develop. Cubes tend to form in relatively cool environments, while the very complex crystals form at exceedingly high temperatures. Of all these forms, the cube and octahedron are most common. Add to all this fluorite's habit of twinning, usually with two crystals penetrating each other, and this calcium fluoride finds it way into many a collection.

Fluorite has a host of industrial and even hygienic uses. It is used in glass making and in toothpaste, but its major use for centuries has been as a flux to reduce the temperature necessary to melt metal ores. Its name, in fact, is from the French word for flow, fluere. The great fluorite deposits of southern Illinois and

northern Kentucky famous for their wonderful abundance of fine crystal specimens were mined intensely for decades Cave in Rock, Illinois, is one such deposit There actually is a cave overlooking the Ohio River It was a hangout for river bandits during the early days of this country and it was one of several important fluorite sources

One of the types of fluorite you've undoubtedly seen from this area is the small, perfect octahedron forms sold for a few cents to a dollar or so These are actually cleavages of fluorite, not crystals as such Miners, often after they retired, would sit with a razor blade and a chunk of fluorite and by holding the fluorite so they could slide the blade along their thumbnail and hit the fluorite firmly, took advantage of the perfect cleavage of the mineral The fluorite would cleave, and when this process was repeated eight times on the same piece, the result was the little octahedron cleavage they collected

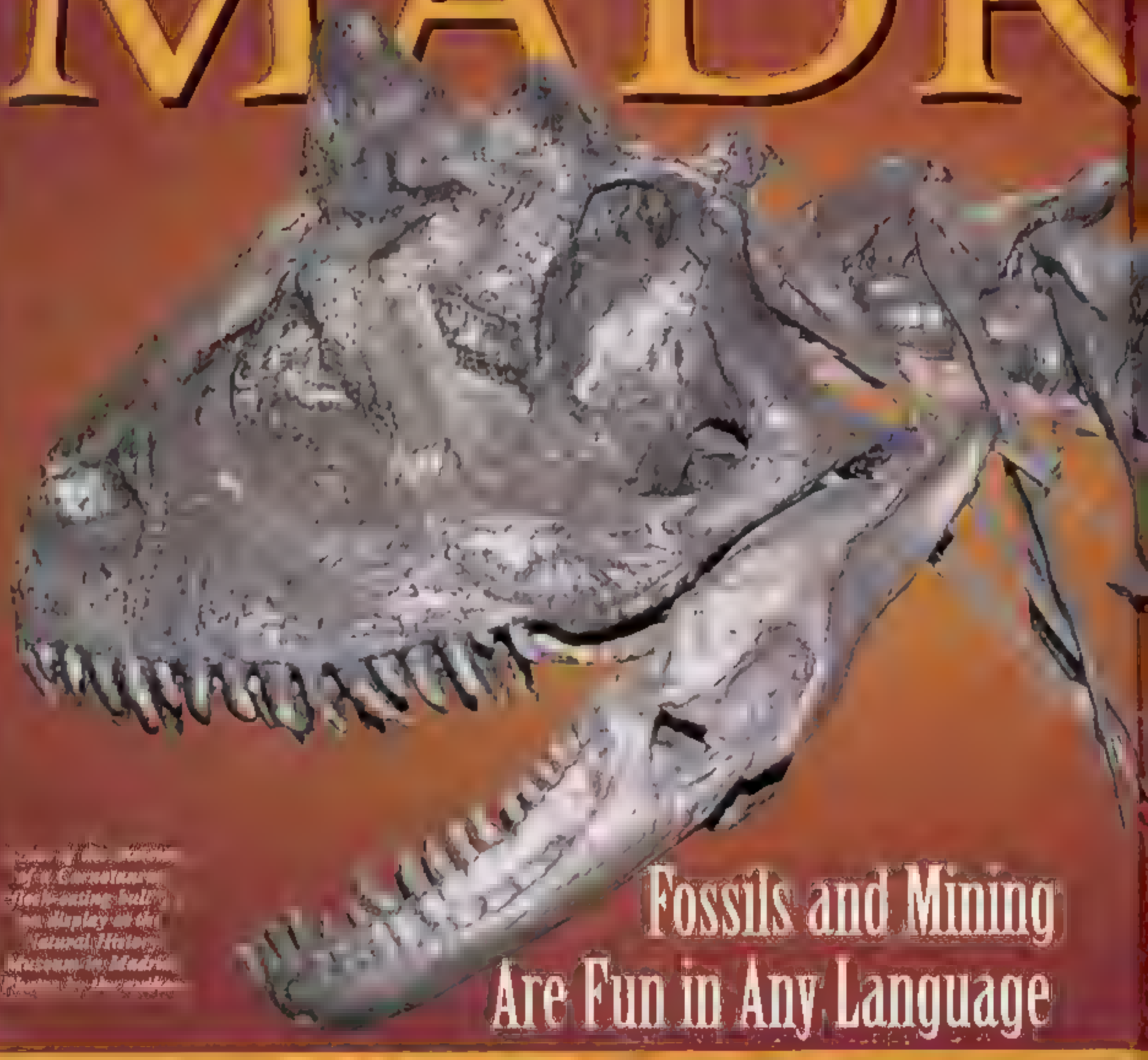
Sources for this abundant mineral are almost too numerous to name Some of the classic sources are mentioned above The German silver mines are another source One of the very important ancient deposits in England is at Tray Cliff Castleton, where the fluorite formed in thick seams of banded yellow and blue This fluorite was called Blue John perhaps after the French words for the colors, bleu and jeune This very attractive material was mined extensively as a decorative stone The largest carved piece of this bicolored fluorite is at Chatsworth House, home of the Duke of Derbyshire The piece is a taza that stands nearly 2 feet high and almost as wide The bowl and pedestal are each carved from a single piece of relatively dark Blue John fluorite

Among American classic localities are the limestone quarries in the Midwest, the gold mine at Silverton, Colorado, and other Colorado sources Mexico has also been a fine source of this calcium fluoride, though the supply seems to have diminished

Today, superb fluorite is still coming from Russia, China, and South America in a variety of colors and excellent specimen forms My favorite is the luscious green fluorite being mined recently as superb octahedron crystals and gemmy masses from the Wise Mine in Westmoreland, New Hampshire

This leaves us with Mohs scale hardness minerals apatite feldspar, quartz, topaz, corundum and diamond These lovely and useful minerals will be given similar treatment in next month's issue of *Rock & Gem*

# ROCKING IN MADRID



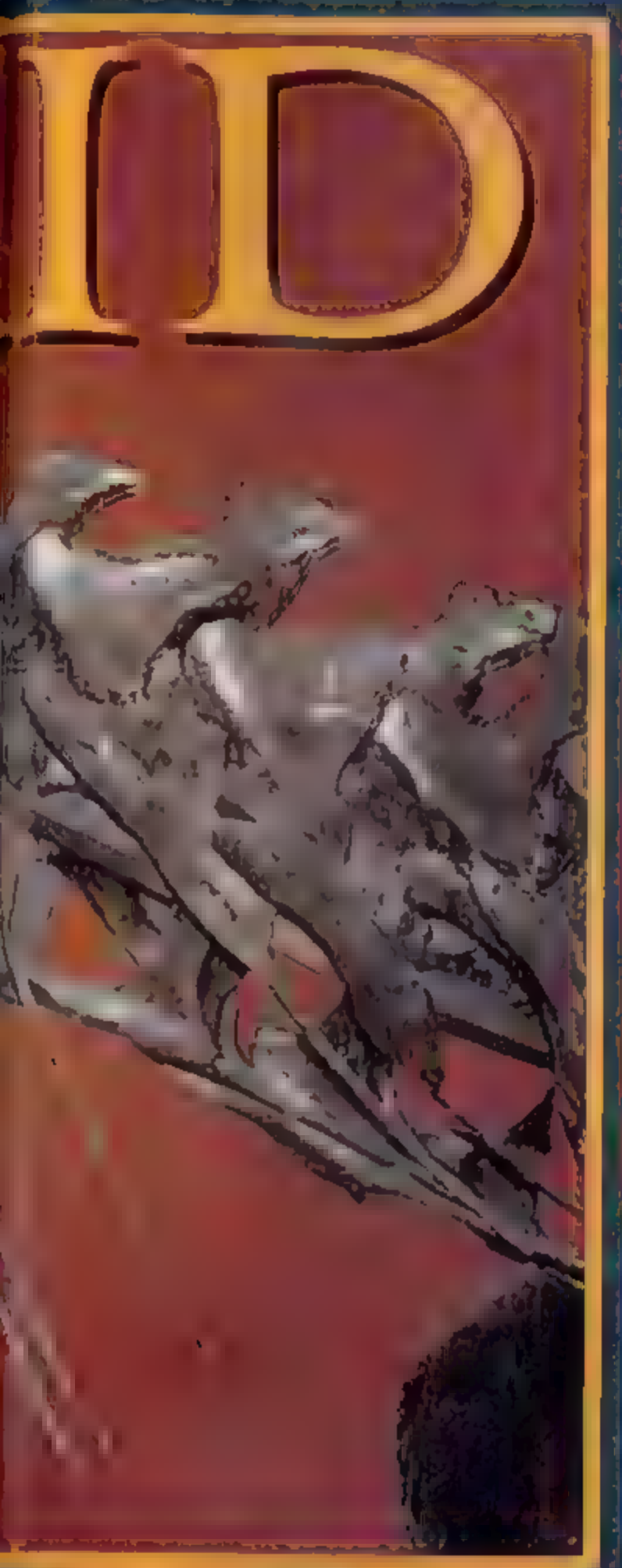
## Fossils and Mining Are Fun in Any Language

*by Murray Eiland*

Madrid offers a wide range of things that are of interest to rockhounds, and what follows is an attempt to back up the claim. Given the scope of local museums, from rocks to fossils through early mining, this is not a difficult task. Most people, particularly in the Western United States, will have picked up enough Spanish—either passively or through course work—to have little difficulty with the language. For those who have not, rest assured that Spaniards, even in a big city, are pleased to help. The metro system is both fast and easy to maneuver, so that with few exceptions it will be possible to walk from a station to a major point of interest.

The place to visit first is the Museo Geominero. The title of this museum does not accurately convey the contents. The museum is particularly strong in fossils, and the setting is splendid. It is situated in the first floor of the Institute of Geology and Mining of Spain, which was built between 1924 and 1925, and inaugurated by King Alphonso XIII in 1926 during the 14th International Geological Congress in Madrid. It boasts monumental stairs made from white marble from Macael in Almería. The central hall is 19 meters high and contains 250 cases. On the ground level, there is a selection of minerals and fossils, as well as a large fossil mammoth in the middle.

There are plush couches on the ground floor, where after several hours of looking at the exhibits one can sit under the huge stained glass skylight and enjoy the view. Indeed, it is one of the best—and quietest—places in Madrid. This is clearly what the museum was designed to be, as with an unknown specimen in hand it would be possible, after a fruitful search, to



Visited and even assembled with the construction of this museum. Former Spanish territories are also well represented, from the Philippines to Cuba and the Western Sahara.

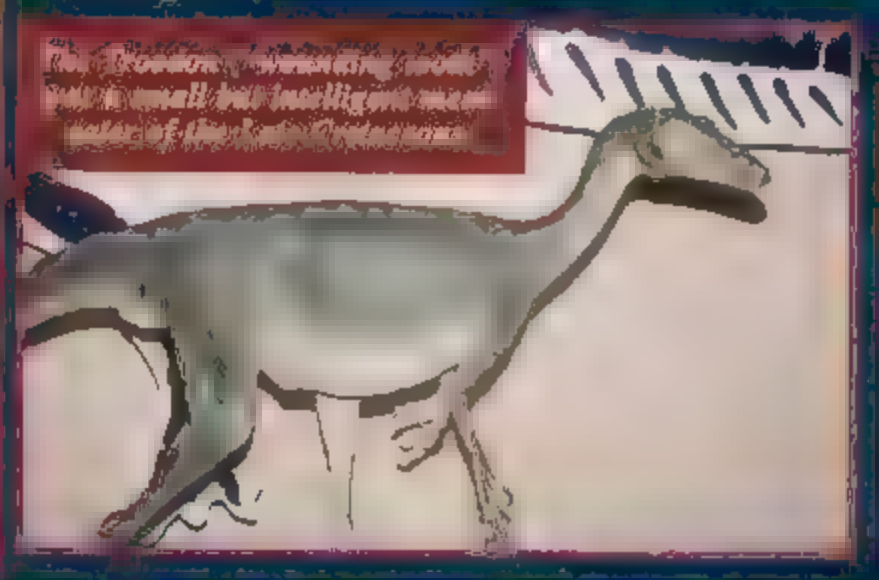
This collection of fossils is unique in Spain and contains a number of important specimens. There are a host of fossil ammonites (Mesozoic) and trilobites (Ordovician), as well as corals (Cretaceous). There is also a good display of plants (Carboniferous). It is a good idea to carry a map of Spain with you as you examine the specimens, as most types are from famous localities. American specimens at times cast are also present. A replica of the most complete Tyrannosaurus rex skull recovered from South Dakota stares down from one of the balconies, representing the vertebrates. There are Paleocene shark teeth from Malaga, Huelva. There are also frog and other Miocene amphibians (which have not received detailed attention) from Teruel and Castellon. There are also traces of Triassic reptiles from Guadalajara.

For big fossils, travel to the Natural History Museum (Museo Nacional de Ciencias Naturales). This is a huge building, and there are two parts. The part with fossils and a few rocks is opposite where one buys the tickets. There is a small "rock garden" with huge chunks of interesting rock bearing descriptions. Inside the building, a few impressive dinosaurs can be found among the cases of invertebrates. Pride of place is given to the replica Diplodocus skeleton from Pittsburgh, donated by Andrew Carnegie. This goes to show how important the Jurassic (208 million to 146 million years ago) of Wyoming is to the world.

There is a spectacular Carnotaurus skeleton that is 25 feet long and 6½ feet tall at the hips. The animal must have weighed about a ton and lived during the Middle Cretaceous (121 million to 91 million years ago). It takes some imagination to see that this animal looks like a bull, as the name suggests, though the "horns" above the eyes may have given some weight to this name. It is likely that these projections were more important for muscle attachment and protection of an otherwise deli-

cate area of the skull than as weapons used for butting other animals. The small arms of the creature were smaller even than those of the Tyrannosaurus rex, and were likely used for tearing off pieces of flesh from prey rather than for subduing it. The eyes face slightly forward, suggesting that it had binocular vision—a rarity for the dinosaurs, but of great value if you are a predator.

The Troodon model of the Late Cretaceous (76 million to 70 million years ago) is familiar to North Americans. Many Troodon fossils have been recovered from Alberta and Montana. This fast, light predator is assumed to have been as intelligent as a bird. It has the largest brain in relation to body size of any dinosaur. It walked on two legs and could use its stiff tail for balance while running. The serrated teeth and birdlike jaw provide a suitably cunning look.



While America is known for dinosaurs, Europe is well endowed with mammals. A good example is the Deinotherium fossil, translated from Greek, the name means "terrible beast." It represents an extinct genus of elephantlike mammals. The most noticeable difference between this animal and modern elephants is that the tusks point downward and backward from the lower rather than upper jaw. In the flesh, they had shorter trunks than modern elephants as well. They are encountered in the Miocene and early Pliocene of Europe and Asia. The Miocene (23 million to 5 million years ago), compared to the previous Oligocene or following Pliocene, was a time of warmer global climates. Ocean and weather patterns changed as the circumpolar ocean currents cut off the mixing of warm tropical water and cold polar water. As a result, the Antarctic developed an ice cap, and the interiors of continents became drier. At first the global climate warmed, then it cooled, favoring the creation of wide swaths of grassland. This led to the rise of huge herbivores that could fend off the cold—not to mention predators—with their size. The Pliocene Epoch (5 million to 1.8 million years ago) witnessed the increasing diversification of mammals in the steppes. It was a cooler and drier time than the Miocene, and grassland continued to spread across the continents.

continued on next page

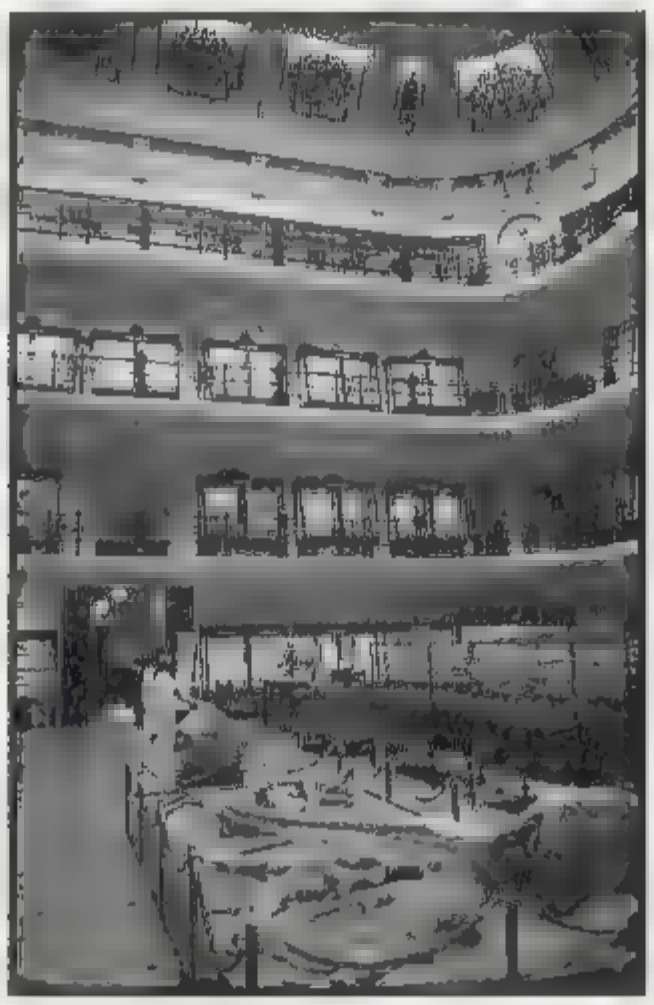
One of the most striking big mammals on display is the Megatherium americanum, the largest species of giant ground sloth. The name literally translates as "great beast," and after looking over the thickset herbivore, one has to agree that the name is apt. It walked on all four legs, but probably ate leaves from trees while standing on two. Like many large mammals, it lived during the Pleistocene, and became extinct about 11,000 years ago. The first specimen was named by Richard Owen in Brazil. The specimen in the museum is about 1.8 million years old and comes from Argentina.

At the end of the last ice age, between 15,000 and 10,000 B.C., over 80 percent of the large mammals went extinct. The exact cause remains a matter of debate. Some suggest human intervention, and others insist climate change. Those sitting on the fence posit both factors. Whatever the case, humans arrive on the scene at suspiciously the same time as the great extinction. Early humans of whatever continent were not prone to preserve their environment while searching for food or while engaged in technological progress.

Perhaps not surprisingly, the Natural History Museum also has examples of rocks and minerals important to humans. Economic minerals are found in the Madrid region, which boasts what is billed to be the largest deposit of cat litter (sepiolite) in the world. It is a fine, white, claylike mineral (a hydrous silicate of magnesia) that when dry is light enough to float on water. It is also known as meerschaum, which comes from Turkey and is used to make distinctive pipes. The largest deposit of mercury in the world is El Almaden, and the Romans had a copper and iron bonanza at the Rio Tinto mines. The name Rio Tinto translates into "colored river," which refers to the water that emerges from the mines.

The mines are still used today, though now there is a crater about 800 feet deep. The ores on the surface were green blue oxides, while at lower levels chalcopyrite ores were found. These deeper ores, because they contain sulfur, were much more difficult for the ancients to use. This is where the Moors emerge as innovators by necessity. The Romans had used all the oxide ores, and by the Middle Ages, only sulfides could be found. The Moors reused Roman copper tools, but were at first unable to smelt copper from the sulfide ores from Rio Tinto, which had high iron and lead impurities. They broke ore into small fragments and piled it in heaps, allowing water to penetrate the pile. The water containing copper sulfate could then be collected. If iron was placed in the water, the copper precipitated while the iron dissolved. Although this method worked, it could take years!

*The Museum of Natural History in Madrid features a rock garden with huge chunks of interesting rock bearing descriptions.*



*The Museo Geominero boasts opulent surroundings for the best geological collection in Spain.*

We are not done with the Romans yet, as they left extensive traces of mining across Spain. Las Médulas (in the modern province of León) has been cited as one of the most effective and best-preserved gold mines in the Roman Empire, but is today a series of channels constructed in the 1st and 2nd centuries A.D. Gold does not usually occur naturally in great quantities, and various methods were employed to concentrate it. While panning could be used for small scale mining, larger scale methods required vast capital investment, but the returns were worthwhile. Some channels reached to 80 kilometers deep and were just under 2 meters in width. Organic remains are not preserved, but the descriptions of the classical author Pliny the Elder (23–79 B.C.) give some indication of how the gold was collected using wooden baffles to trap gold particles.

There were also other natural resources that were of interest to the Romans. Before the introduction of window glass, Lapis Specularis (gypsum) could be used. The name clearly refers to its transparency. It is clear and has a regular cleavage that yields sheets of rock. At a time before scientific mineralogy, classical writers classified stones according to their color and form—paying attention to how they could be used—and geographical location. As a result, different minerals with similar characteristics (according to the ancients) could have the same name. Pliny records deposits of Lapis Specularis from the city of Segobriga in the modern province of Cuenca, but notes it is also recovered from other regions (e.g., Cyprus, Cappocia, Sicily and Africa), though he suggests that the stone from Spain had superior clarity and was more easily cut. Spanish mines could yield gypsum sheets up to a square meter.

The difficulty of mining led to the introduction of a variety of new techniques. Ancient pumps, though they were clearly also used for other purposes, are today associated with mining. Vitruvius, in his well-known work *On Architecture*, describes the elements of this kind of pump. He notes that they are very powerful and made of bronze, though there are surviving examples made from lead and wood, as well. Two identical cylinders with pistons are equipped with two valves that open and close alternately, forcing the flow of water to the spout. Careful polishing was required to ensure that the elements fit together. All of the pumps that survive are powered by hand, which would have limited the power of the pump considerably. Yet, this kind of pump continued to be used long after the Roman period, as they were simple to make and easy to transport. In Spain, at least two pumps, one made of lead and

the other of bronze are preserved The first was recovered n the lead mines of Sierra de Cartagena and as it was made of lead, it is interesting to speculate whether it was made rom local materials The bronze example the best preserved of all known was recovered from a mine at Serad Corobada and is now in the National Archaeological Museum Madrid As an aside, his museum contains several other things relating to ancient mining, and should not be missed!

This pump is far more important than a piece of plumbing and still has many features that suggest how sophisticated the Romans were It has several modifications that increase the velocity of water most notably the two branches of water that are ported into one at the tip of the spout The reason these pumps were found in the mine is still not clear It is unlikely that the pump was simply used to convey accumulated water up from the mine shafts, though admittedly this was a significant factor that would be tackled using direct pumps It is far more likely that a high powered blast of water was needed either for putting out fires on the wooden struts supports or to break heated rocks The latter hypothesis is perhaps the most convincing After being heated with fires and cooled quickly with a blast of water rock is easily shattered This method of mining lasted well into the 16th century in Spain The question remains did the Romans or perhaps more specifically the literature have this level of understanding

All the museums mentioned here are located in central Madrid The Museo Geominero is at Rios Rosas 23 and is a short walk from the Rios Rosas metro station Admission is free and opening times are Monday through Friday, 9 a m to 2 p m (Web site www gmes es/museo museo htm)

The Museo Nacional de Ciencias Naturales is at Jose Gutierrez Abascal and can be reached from three metro stations Gregorio Marañon, Nuevos Ministerios, and Rios Rosas Admission is 3 euros and opening times are Tuesday to Friday 10 a m to 6 p m , Saturdays 10 a m to 8 p m and Sundays and holidays 10 a m to 2 30 p m (Web site www mncn csic es/english/index1 html)

The Museo Arqueologico Nacional is at Serrano 13 and can be reached by the metro from two metro stations Serrano or Retiro Admission is 2 50 euros, free on Saturday afternoon and Sunday Opening times are Tuesday to Saturday 9 30 a m to 8 30 p m , Sunday and holidays 9 30 a m to 2 30 p m (Web site www man es)

# ROCK SCIENCE

by Steve Voynick

## A Fossil in the Flesh

In May 2002, the Phillips County Museum in Malta, Montana, unveiled its newest paleontological display and one of the most remarkable fossils ever found the completely mummified remains of a 77 million year old hadrosaur, or duckbill dinosaur Named "Leonardo" after an inscription on a nearby sandstone cliff, the fossil is the first mummified dinosaur found in more than 90 years

Fossilized remains of soft tissue are exceedingly rare Soft-tissue impressions, usually only small sections of skin or scales are found in just one of every 1,000 fossils But because more than 75 percent of Leonardo's skin has been preserved along with many internal organs, paleontologists have gotten their first look ever at the fossilized skin of a dinosaur's face and at its stomach contents

Phillips County Museum Curator of Paleontology Nate Murphy calls Leonardo a world class fossil that is providing new insights into dinosaur appearance, diet and habitat

Leonardo was excavated during the summer of 2001 by a team from the Judith River (Montana) Dinosaur Institute that consisted of 25 volunteers paleontologists geologists, and paleoartists The difficult excavation began after a bulldozer had cut a road to the site and an explosives expert detonated low impact charges to remove the large boulders that covered the fossil After overburden had been bladed away the excavation team began digging a 6-foot-deep trench around the perimeter of the fossil

A short crest on the newly exposed skull indicated Leonardo was a duckbill dinosaur Even before excavation was complete, paleontologists determined Leonardo to be a Brachylophosaurus, only the fourth such specimen ever found and the first that was fully articulated

After Leonardo was removed as a single block of plaster-encased rock weighing seven tons months of additional work were needed to prepare the specimen for display

"When we cut the last bit of rock from him it was quite an emotional moment," said geologist and preparation-team member Mark Thompson "We could then see for the first time how small and young this little guy was when he died"

In life, Leonardo was a subadult about three or four years old with an overall nose-to-tail length of 22 feet Paleontologists initially believed that Leonardo died on a remote sandbar that was inaccessible to predators and that long days in the sun had dried out its remains, preserving the soft tissues in a leathery fashion Eventually, the entire desiccated body became buried and fossilized But paleontologists have since revised their theories about Leonardo's preservation

"We now think that it was buried in wet river sand around 77 million years ago, and that much of the flesh was intact when fossilization started," says paleontologist Dave Trexler a co-author of Leonardo's technical description "The type of pollen from its stomach also shows that the environment was much too wet for desiccation to take place before burial"

The fossilized contents of the stomach have proven fascinating to paleontologists for they indicate exactly Leonardo's last lunch The menu includes terms conifers, and a magnolia type plant This information provides insight into both hadrosaur diets and Late Cretaceous flora

Some of Leonardo's other interesting features are a three dimensional rock cast of the right shoulder muscle and throat tissue, large sections of skin, toenails, beak, and internal organs, all of which shed light on how hadrosaurs were built, moved and behaved Studies of the surprisingly massive fossilized muscles are indicating that hadrosaurs used their forelimbs much more than previously thought

Curator Murphy notes that Leonardo is only the third complete mummified dinosaur ever found and that the previous two had been excavated nearly a century ago "The techniques of that time did not allow for the study of the more delicate features, many of which were inadvertently destroyed," he explains But his specimen gives us the chance to apply more modern scientific techniques to answer old questions

Thanks to Leonardo, much more knowledge about dinosaurs seems certain to emerge as scientists enjoy a rare opportunity to study a fossil in the flesh

# Visiting the Yowah OPAL Festival

*Rachel Lewis produced this winner of the under $500 Yowah Jewelry Design Competition. (photo courtesy the Opal Hut Yowah)*

*Stephen Millton, Doug Brooks, Barbara Gasch and Tony Clarke attended the 2002 Yowah Opal Festival with selling smiles. (Photo by Joan Millton)*

# Enjoy Outback Hospitality at This July Event

*by Joan Millton*

Going to the Yowah Opal Festival in July is one of the biggest treats in our travels around Australia. Why? Well, the people there are some of the rare gems of the Earth. The members of this tiny, hardy mining community mine during the winter and live in a more hospitable place or travel during the summer. Their open-home policy is wonderful; when you visit the place, you are invited to "noodle" on their claim, and then you are often invited to meals and to stay the night. Mind you, this is the outback, and motels, hotels and pubs are not readily available. Sleeping in tents or caravans is the norm out here.

The Artesian Caravan Park run by the Ian Richardson family has the only undercover rental accommodation in town. The six cabins are as comfortable as you need to live in for the time you are there: a light minus a shade in the middle of the room, bare concrete walls, a gas "stove" and a sink, the modern miracle of a microwave oven, plus a small room at the back with the usual asset. *But* when you go outside to the hot tubs or showers, then you know you are in paradise. The artesian water is so enervating; to lie back in the hot water and enjoy gazing at the sky (most tubs are in roofless rooms) is one of the joys of life. There is no other water in Yowah; in order to drink the artesian water, you have to draw your jugs and leave them to "air" until the water is cold before using it for coffee or tea (we take bottled water with us).

*Gary Hainsworth's work won the Overall Peoples Choice in the 2002 Jewelry Design Competition. (Photo courtesy the Opal Hut Yowah)*

The weather is superb: shirtsleeves are comfortable in the hot, sunny days of late winter, and then if you're being entertained, you sit around the inevitable nightly bonfires needing only a warm outer covering. All in all, this part of Western Queensland has its special moments.

The 2002 Opal Festival was as good as usual; the three days were full of camaraderie, meeting old and new opalholics, and enjoying the bush entertainment—one memorable moment was a ballad written and sung on stage by a seasoned performer of 8 years of age. The takings at the gate, I was informed, were for the Flying Doctors, so that made parting with a few more dollars very palatable.

*continued on next page*

*Ian "Mac" McArthur's first-place winner "Opal Breastplate" combines opals, leather, silver, and gold plate. (Photo courtesy Opal Hut Yowah)*

## Visiting the Yowah Opal Festival *from page 81*

As the evening rolls around, food is on one's mind. For a number of years, the tiny community spent many months planning and finally preparing a dinner that would feed at least 250 very hungry people under the guidance of Gwen Burney, a local resident and former gourmet caterer. Unfortunately, this meant that the volunteer workers were not able to enjoy the festival along with the visitors, so they now engage the services of a local caterer. It can't be easy "guess-timating" how many will turn up and how long they will stand and talk in the long, winding queue before the meal goes cold, but that's all part of the fun of "dining out"!

When the time comes to browse among the tailgaters on Saturday and Sunday mornings, you are faced with incredible choices of what opal to buy. Miners attend in droves, and you can buy anything from a speck to a large specimen, with prices just as elastic. "Willy willies," gusts of wind and clouds of dust, are all part of the fun of being out in the elements. It's just the big gusts that blow the goods off the table that you have to watch out for! Getting a sunburned face in the middle of winter is not unusual here.

The Festival is great fun no matter what complaints you can come up with. It is three days full of activity, and it means so much to the mining community to have visitors from all over the world turn up to enjoy an outback adventure. I met Americans, Germans, Japanese, Danes and other Europeans (many on return visits) who came to buy the beautiful opals from Yowah, Blackgate and nearby mining areas, and to have a "noodle" in the open mining area for themselves. You can also dig your own opal at the Sawickis' Ben Hur and Cleopatra mines, near the Leopardwood opal mines not far from town, with a guarantee. If you don't find opal, they refund you the $10 it costs to mine for the day. What a generous deal!

In 2002 there were helicopter rides, a design jewelry contest, and the annual windlass heats and finals. Instigated some years ago, the design jewelry competition, using Boulder Opal, was again an excellent display of well thought-out pieces. A bejeweled opal breastplate by Ian MacArthur was stunning and was displayed on the cover of a very well-known international ladies' magazine.

The choice of the awards handed out was well received by the enthusiastic crowd sitting around the huge bonfire on Saturday night. Barbara Gasch, the popular senior judge, knows her subject well. She made her name in Germany as one of the more progressive jewelers there before discovering the Whitecliffs opal fields and fulfilling her dream of living in an underground home (cave). Barbara creates masterpieces all day long in her studio for Outback Treasures, the shop her husband, miner Doug Brooks, manages for them both. She is more than content to live in isolation in the outback, making judging trips to jewelry exhibitions around the fields to renew friendships.

Brownie Helsham of the Wandera Mine offers walk-in mine tours. Her many long years at Yowah make her one of the mining experts there, so joining her tour is a good idea if you look for the fabulous "Yowah nuts" only found in the mining area at the edge of town. No one has any idea what these nuts contain until they are cracked open, and then you could discover a solid core of opal, showing the spectrum of all the opal colors, that takes your breath away.

As the terrain is absolutely flat, walking is a joy, and when wandering around the small township, you note the number of miners who sell from their homes. However, the best-kept secret of Yowah is a young lady of 17, who is an indigenous artist. Jolene Hava has a very bright future; her Aboriginal art is very colorful and well executed, and as an artist myself, I found her work very appealing. Her younger brother Michael, 16, who makes very handsome and authentic didgeridoos carefully selected from the dead wood of Yowah trees, has a bright a future as a craftsperson, as well. Don't hesitate when you see a sign on the gate at the end of Matrix Street that says their art is for sale. It is well worth looking at and buying.

During our visit to the Havas' home, kangaroos leaped through their yard. It seems that shutting gates meant mending broken fences; with the 2002 drought on, the town was full of hungry 'roos with no grass or other vegetation to eat, and they were devouring anything they could find, even cardboard boxes and the toast given them by residents (they won't eat bread). And yes, kangaroos can become quite unpredictable when confronted in confined areas, so beware of these "southpaws." They are dirty fighters!

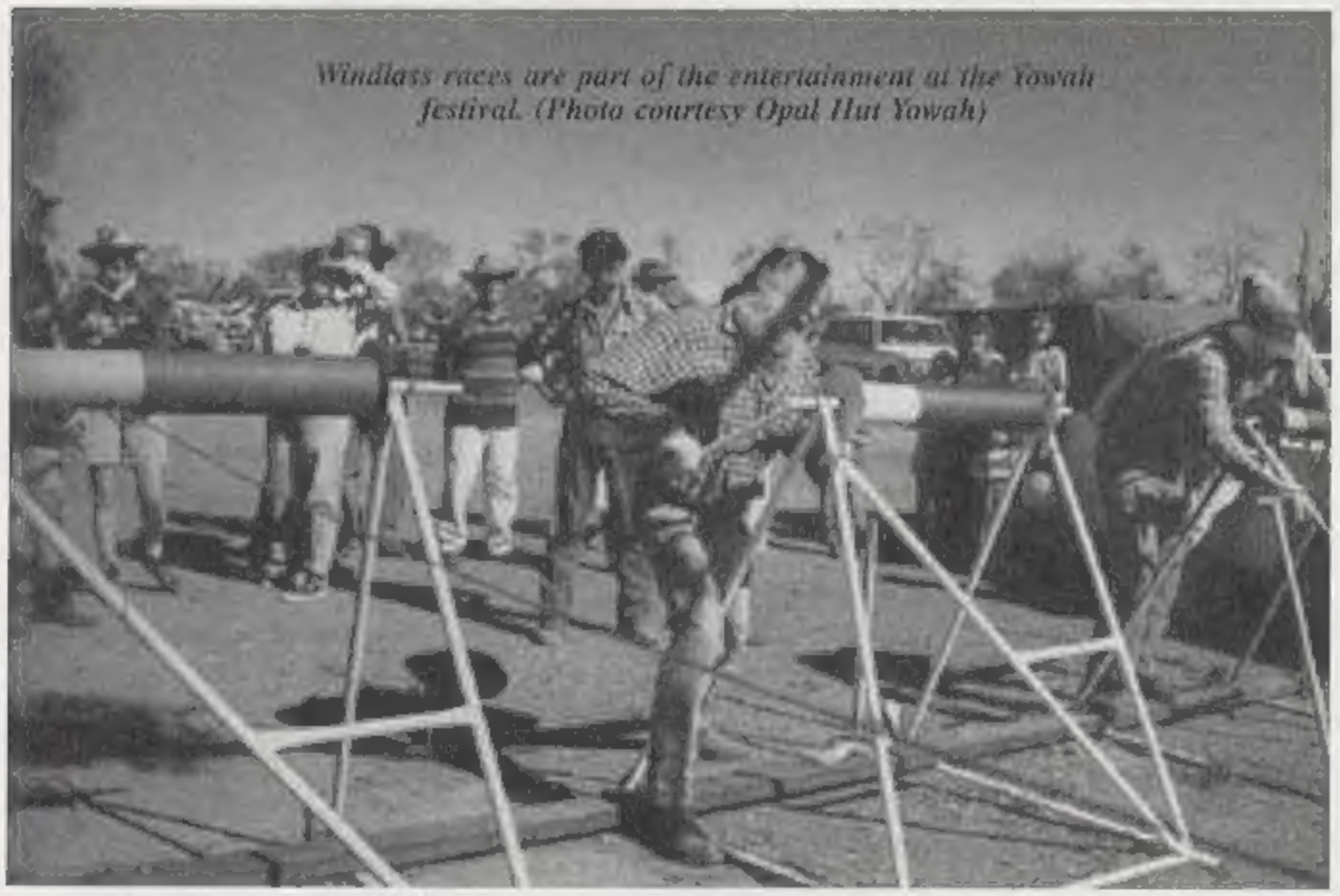
You may decide to take a vacation in Australia, to see this famous outback country and to attend the memorable and enjoyable Yowah Opal Festival in July (the middle of winter in Australia). To make sure you can spend your time very conservatively and wisely, depending on how many days you have for your vacation, I'd suggest the following:

- Bring a lightweight sleeping bag with you—unless you book your accommodation at the Artesian Caravan Park.
- You'll need warm outer clothing for nights under the sky, but you can actually get away with summer shirts during the day, adding a light sweater if the sun doesn't shine (but it usually does).
- Write to the Queensland Government for maps, etc. before you come. Otherwise, the RACQ in Brisbane can supply you with them, or you can contact us at msg@powerup.com.au and we'll try to help out.

One of the more convenient ways of arriving at your destination is to fly directly into Brisbane Airport and then, armed with maps, drive directly west to Eulo, the gateway to Quilpie and Yowah. You have a choice of two routes to take.

We prefer to drive out via Charleville and Cunnamulla, just because of the chance of finding petrified wood at Chinchilla on the way, and if you are one of the luckiest people on Earth, you might just come across a piece of Pentoxilin wood, a part of goanna land history going back millions and millions of years before the Australian continent became one land mass. These rare Jurassic pieces contain *five* hearts entwined, which are very evident in the cross section of a log.

The return trip via St. George is about 200 kilometers shorter; however, if you don't



*Windlass races are part of the entertainment at the Yowah festival. (Photo courtesy Opal Hut Yowah)*

*In the underground tunnels of this mine, the opal layer is halfway up the wall. (Photo courtesy Opal Hut Yowah)*

want to spend the 12 to 15 hours on the road, there is an airport at Yowah that services small planes and the flying doctors' aircraft. But if you enjoy the idea of seeing the bush and native animals, then driving directly from Brisbane due west through some of the country towns is fun. And when you turn the radio on, you find familiar country Western music is on the airwaves.

Unfortunately, we do not have the foresight when scheduling a celebration to tell whether the elements will be cooperative. 2002 was one occasion when Australia got the year wrong, asking everyone to go outback to celebrate the country's existence. Maybe El Niño, lurking somewhere out there in the Pacific Ocean, had something to do with the drought that held much of Queensland and 80 percent of New South Wales in its grip. The drought resulted in a much greater loss of native animals, stripped the landscape, prepared the bush for raging fires, and financially ruined a lot of hard-working landowners.

Outback roads are pitch black at night; the only light one has to travel by is the headlights of the vehicle. Kangaroos seem to like to run directly into the lights rather than away off into the bush, so you have little chance of avoiding them head-on. 'Roo bars are fitted to outback vehicles for just this reason. Even in the good times, you'll have large 'roos crossing in front of you, so the odd carcass lying on the road is expected, but this was a nightmare. And the prediction is that the drought has only just begun to take hold and can last for several years more.

Remember now, you need to travel to Yowah in either a camper or a caravan, or take a good tent with warm bedding. The nights are darned cold, but those beautiful, warm days with clear blue skies make up for it all. And who knows, you could just find an opal that pays for your trip ... and maybe a return visit!

# Show Dates *from page 78*

**30-1—VEGAS, NEVADA:** Annual retail/wholesale show; The Bead Renaissance Shows; Palace Station Hotel/Casino, 2411 W. Sahara Ave.; Fri. 12-6, Sat. 10-6, Sun. 10-5; free admission; ancient, vintage and contemporary beads, buttons, jewelry, tools and books; contact Glen or Joan Johnson, J&J Promotions, P.O. Box 420, Williamsburg, NM 87942, (505) 894-1293; e-mail: info@beadshow.com; Web site: www.beadshow.com.

**31-1—BOZEMAN, MONTANA:** Show; Bozeman Gem & Mineral Club; Gallatin County Fairgrounds, Tamarack and Black; Sat. 10-6, Sin. 10-5; contact Marvin Bratten, 19000 Crystal Mountain Rd., Three Forks, MT 59752, (406) 285-6719.

## JUNE

**5-8—VENTURA, CALIFORNIA:** Show, "Seaside Gemboree"; Del Air Rockhounds Club; Seaside Park, 10 W. Harbor Blvd.; Thu. 10-5, Fri. 10-5, Sat. 10-5, Sun. 10-4:30; adults $5, juniors (12-17) and seniors $4, children under 12 free with adult; dealers, demonstrations, exhibits, silent auction, jewelry, gems, crystals, fossils, youth activities, mermaid's grotto; contact Del Air Rockhounds, P.O. Box 7618, Van Nuys, CA 91409, (818) 883-7851; (818) 347-2056; Web site: www.afms-cfmsgemshow.org.

**5-8—WESTMINSTER, COLORADO:** Mile High Rock & Mineral Society; Westminster Mall, 88th and Sheridan; Thu. 10-9, Fri. 10-9, Sat. 10-9, Sun. 11-5; free admission; contact Jennie Baldwin, 25100 Bromley Ln., Brighton, CA 80603, (303) 659-7630; e-mail: ctunnicliff@msn.com.

**6-8—PUYALLUP, WASHINGTON:** Show, "Valley of Gems"; Puyallup Valley Gem & Mineral Club; Fruitland Grange, 112th St. and 86th Ave. E; Fri. 12-7, Sat. 10-6, Sun. 11-5; silent auction, kids' activities, club sales, demonstrators, gem displays, gem and jewelry dealers; contact Paul James, 5044 S. Park Ave., Tacoma, WA 98408, (253) 475-8060.

**6-8—RALEIGH, NORTH CAROLINA:** Show; Frank Cox Productions; State Fairgrounds, Blue Ridge Blvd. and Hillsborough; Fri. 1-7, Sat. 10-5, Sun. 10-5; gems, jewelry, crystals, minerals, beads; contact Frank Cox Productions, 755 S. Palm Ave. #203, Sarasota, FL 34236, (941) 954-0202.

**7-8—BIRMINGHAM, ALABAMA:** 30th annual show; Alabama Mineral & Lapidary Society; Tannehill Ironworks Historical State Park, I-20 exit 100 or I-459 exit 1, follow signs; Sat. 9-5, Sun. 9-5; contact Sandra Sullivan, P.O. Box 811, Trussville, AL 35173; e-mail: doodle_35173@yahoo.com.

**7-8—RACINE, WISCONSIN:** Swap and sale; Racine Geological Society, Bratlett Youth Foundation, 1120 N. Stuart Rd.; Sat. 10-5, Sun. 10-4; free admission; Bonnie Wozniak, 4042 N. Main St., Apt C3, Racine, WI 53402, (262) 752-4962; e-mail: bnw3@sbcglobal.net.

**7-8—SAN FRANCISCO, CALIFORNIA:** Show, "Great San Francisco Crystal Fair"; Pacific Crystal Guild; Fort Mason Center, Laguna at Marina Blvd.; Sat. 10-6, Sun. 10-4; contact Jerry Tomlinson, (415) 383-7837; e-mail: sfxtl@earthlink.net; Web site: www.crystalfair.com.

**13-15—PARK HILLS, MISSOURI:** 6th annual swap and sale, "Missouri Mines Rock Swap"; Mineral Area Gem & Mineral Society, Greater St. Louis Association of Earth Science Clubs; Missouri Mines State Historic Site, Hwy. 32; Fri. 9-6, Sat. 9-6, Sun. 9-5; free admission; free admission to mining and mineral museum during the swap; rocks, minerals, fossils, lapidary; contact Lloyd E. Marler, (573) 431-2951, or Missouri Mines SHS, P.O. Box 492, Park Hills, MO 63601, (573) 431-6226.

**14—CARTERSVILLE, GEORGIA:** 15th annual show, "RockFest!"; Weinman Mineral Museum; Weinman Mineral Museum, I-75 exit 293 (Hwy. 411 behind Holiday Inn); Sat. 10-5; free admission; contact Terry Everett, 51 Mineral Museum Dr., White, GA 30184, (770) 386-0576; e-mail: terrye@weinmanmuseum.org.

**14—KENT, CONNECTICUT:** Swap and sale; Connecticut Museum of Mining and Mineral Science; grounds of the Connecticut Antique Machinery Association, Rte. 7; Sat. 9-4; contact John Pawloski, 42 Squash Hollow Rd., New Milford, CT 06776, (860) 354-0296.

**14-15—CAYUCOS, CALIFORNIA:** Show; San Luis Obispo Gem & Mineral Club; Vet's Hall at the Pier; Sat. 10-6, Sun. 10-5; free admission; gems, jewelry, minerals; contact Bob Hurless, 2290 Greenwood, Morro Bay, CA 93442, (805) 772-7160.

**14-15—JOHNSTOWN, NEW YORK:** Show and sale; Fulton County Mineral Club; Fulton-Montgomery Community College Campus, state Route 67; Sat. 10-5, Sun. 10-5; adults $2, students $1, children under 12 free; door prizes, children's "mineral dig", exhibits; contact Chamber of Commerce, (800) 676-3858, or Bob Hartig, (518) 842-5948; e-mail: phartig@nycap.rr.com.

**14-15—RIVERTON, WYOMING:** State show; Riverton Mineral & Gem Society, Wyoming Mineral & Gem Society; Armory Bldg., Fremont County Fairgrounds, 814 S. Federal Blvd.; Sat. 9-8, Sun. 9-4; admission $2, contact Alice Gustin, P.O. Box 1904, Riverton, WY 82501, (307) 856-3699; e-mail: agustin@wyoming.com.

**20-22—CARLSBAD, NEW MEXICO:** Show; Roadrunner Gem & Mineral Club; Living Desert Zoo & Gardens State Park, 1504 Miehls Dr., off Hwy. 285N; day1: Fri. 9-6, Sat. 9-6, Sun. 9-5; free admission; dealers, displays, silent auction, grand prizes, door prizes; contact Mary Nixon, 1801 Solana Rd., Carlsbad, NM 88220, (505) 885-5509; e-mail: marynixon@pvtnetworks.net.

**20-22—KOKOMO, INDIANA:** 2nd annual show; Treasures of the Earth Gem & Jewelry Shows; Johanning Civic Center, 1500 N. Reed Rd.; Fri. 10-6, Sat. 10-6, Sun. 11-5; jewelry makers, goldsmiths and silversmiths reconstruct, repair, design or make jewelry from customer-selected gems, stones, opals and crystals; amber, opal, mineral and fossil dealers, wire wrapping, wire sculpture, stone setting, hourly door prizes; contact Van Wimmer, Treasures of the Earth Gem & Jewelry Shows, 5273 Bradshaw Rd., Salem, VA 24153-8025, (540) 384-6047; e-mail: van@toteshows.com; Web site: www.toteshows.com.

**20-22—NEWPORT, OREGON:** 40th annual show; Oregon Coast Agate Club; Newport Armory, 541 SW Hwy. 101; Fri. 10-6, Sat. 10-6, Sun. 10-5; dealers, demonstrations, raffle, junior activities, grab bags; contact Ed Obermeyer, 218 SE 98th St., South Beach, OR 97366, (541) 867-6903; e-mail: Edndi@peak.org.

**21-22—LA HABRA, CALIFORNIA:** Show, "World of Gems"; North Orange County Gem & Mineral Society; La Habra Community Center, 101 W. La Habra Blvd.; Sat. 10-5, Sun. 10-4; contact Bill Burns, (626) 286-2896.

**26-29—PRINEVILLE, OREGON:** Show, "Prineville Rockhound Show & Pow Wow"; Prineville Rockhound Pow-Wow Association; Crook County Fairgrounds; Thu. 9-6, Fri. 9-6, Sat. 9-6, Sun. 9-4; free admission; dealers, demonstrations, displays, auction, field trips; contact Prineville Rockhound Pow-Wow Association, P.O. Box 671, Prineville, OR 97754, (541) 548-6675.

**27-29—BLOOMINGTON, INDIANA:** 38th annual show and swap; Lawrence County Rock Club; Monroe County Fairgrounds, Airport Rd.; Fri. 10-7, Sat. 8-7, Sun. 8-4; free admission; gems, jewelry, lapidary materials, minerals, fossils, rocks, supplies, daily silent auctions; contact Margaret Kahrs, 9145 W. U.S. Hwy. 50E, Seymour, IN 47274-9401, (812) 522-6093.

**27-29—XENIA (DAYTON), OHIO:** 5th annual summer show; Treasures of the Earth Gem & Jewelry Shows; Greene County Fair & Exposition Center, 120 Fairgrounds Rd.; Fri. 10-6, Sat. 10-6, Sun. 11-5; jewelry makers, goldsmiths and silversmiths reconstruct, repair, design or make jewelry from customer-selected gems, stones, opals and crystals; amber, opal, mineral and fossil dealers, wire wrapping, wire sculpture, stone setting, hourly door prizes; contact Van Wimmer, Treasures of the Earth Gem & Jewelry Shows, 5273 Bradshaw Rd., Salem, VA 24153-8025, (540) 384-6047; e-mail: van@toteshows.com; Web site: www.toteshows.com.

**28-29—ANN ARBOR, MICHIGAN:** 29th annual seminar; Michigan Gemology & Gemcraft Society; Washtenaw Community College; Sat. 9-5, Sun. 9-4; adults $15 per day, high school students $3 per day; contact Bill Hapiuk, 26099 Dover St., Redford, MI 48239; e-mail: WilliamHapiukJr@msn.com.

**28-29—COLORADO SPRINGS, COLORADO:** Show; Colorado Springs Mineralogical Society; Masonic Hall, 1150 Panorama Dr.; Sat. 10-5, Sun. 10-5; admission $3; contact David Wilson, (719) 635-7891; e-mail: DLWilson@pcisys.net.

**28-29—CULVER CITY, CALIFORNIA:** Show, "Fiesta of Gems"; Culver City Rock & Mineral Club, Culver City Human Services Department; Culver City Veterans Memorial Complex, 4117 Overland Ave., corner of Overland Ave. and Culver Blvd.; Sat. 10-6, Sun. 10-5; free admission; demonstrations in wire working, gem carving, jewelry repair, glass beadmaking, gourd painting, faceting, polymer clay, flint knapping and beading; exhibits of museum displays, designer jewelry, mineral specimens, fossil collections, petrified wood and dinosaur bone; tools, prizes, special games for children; contact Janice Metz, (310) 314-1203; Web site: www.gembiz.com/ccrmc/fiesta.htm.